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EXHIBIT A

(SUBMITTED WITH AMENDMENT B WITH RCE)

Quality Specification for the U.P.C. Printed Symbol

DRAFT

for trial use

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Preface

The Uniform Code Council, Inc. is providing this print quality specification, describing the voluntary standard for the printed, machine-readable representation of the Universal Product Code as a service to industry. The bar code symbol measurements and evaluation methodologies that require the use of standardized verification instruments have been adapted from the American National Standards Institute (ANSI) Guidelines for Bar Code Print Quality, and merged with the U.P.C. unique requirements, as defined in the *U.P.C. Symbol Specification Manual.*

The *Quality Specification for the U.P.C. Printed Symbol* outlined in this manual and the *U.P.C. Symbol Specification Manual* (first published in 1973) describe two separate and independent methods for constructing a quality U.P.C. symbol. While following either manual will produce a valid U.P.C. symbol, the manuals are independent of each other. It is **not** appropriate to attempt to combine all or any portion of the procedures in the two manuals.

The current *U.P.C. Symbol Specification Manual* provides a recipe which when followed exactly will result in a quality symbol. This new *Quality Specification for the U.P.C. Printed Symbol* requires the use of a verifier as a tool to evaluate the quality of the printed symbol.

Testing has shown that there are some U.P.C. symbols on products that are difficult to measure with a verifier. Some of these products are packaged using flexible materials, materials that reflect light specularly, and packages with rounded or irregular surfaces. The use of a verifier on these types of packages requires skill, experience and judgement to obtain a meaningful evaluation of U.P.C. symbol quality.

In the interest of completeness, the reader should also be aware that the U.P.C. symbol is a member of a family of bar code symbols known as U.P.C./EAN. The U.P.C. Version A and U.P.C. Version E symbols (described in this manual), when scanned outside of North America, are scanned with an implicit leading 0 (zero). This makes U.P.C. Version A and U.P.C. Version E symbols fully compatible with EAN symbols and scannable by scanners utilizing the EAN system (administered by EAN International).

EAN 13 and EAN 8 digit symbol formats are also in the U.P.C./EAN family of symbols. The principles stated in this *Quality Specification for the U.P.C. Printed Symbol* will also apply to EAN 13 and EAN 8 symbols. Further details regarding these applications are available from EAN International, Rue Royale 29, B-1000 Brussels Belgium.

Part I General Information

1.1 Introduction

The historic *U.P.C. Symbol Specification Manual* describes a voluntary standard for creating a U.P.C. Follow all the steps detailed for the film master-based process, and a quality printed symbol is almost certain to result.

The *Quality Specification for the U.P.C. Printed Symbol* is an alternate, and equivalent, voluntary standard for the U.P.C. symbol. A family of bar code attributes are detailed.

The U.P.C. quality specification accommodates the needs created by the proliferation of technological advances in U.P.C. printing processes and scanning systems that have occurred during the many years since the publication of the original specification. Applications and devices that cover a broad range of cost and performance needs have accompanied these advances.

This method can evaluate a printed U.P.C. at any point in its life cycle. A sophisticated verifier user at a U.P.C. printer's location, for example, can now use a common language to discuss a problem symbol reported by a less skilled user who has encountered scanning difficulties at the point of sale.

The selection of an instrument, how it is used, and the interpretation of verification results, however, require prudent judgment to assure a meaningful evaluation of the U.P.C. symbol. Compatibility of a U.P.C. symbol to a system's requirements, a verifier's capability, and most of all, people and their constructive dialogue, will assure the quality goals detailed by this voluntary standard.

1.1.1 Purpose

This manual provides detailed specifications for the printed U.P.C. symbol. The manual further states the requirements for a variety of hardware/software methods for the creation and printing of the U.P.C. symbol and the specifications covering measuring device (verifier) methodology.

1.1.2 Summary Description

This specification consists of the following parts:

Part I - describes the code structure and formats of the family of U.P.C. codes and symbol versions. The geometry and dimensional specifications are described in detail.

Part II - provides an overview and interpretation of the measurement methodology and techniques employed by U.P.C. verification devices designed to meet the requirements of this print quality specification.

Part III - provides ANSI based bar code/U.P.C. specific measurements and requirements for the U.P.C. printed symbol. Supports the level of detail required to create or evaluate the quality of the printed symbol.

1.2 U.P.C. Symbol Overview

The symbol comprises a machine-readable bar code and the human readable interpretation of that bar code.

Several versions of the symbol are available. This section will describe the intended uses of, and differences between, these variations, as well as the organization and encoding of the machine-readable bar codes involved.

1.2.1. Version A

1.2.1.1 General Description

Version A, or the regular version, is used to encode a 12 digit number. The first digit is the number system character, the next ten are additional information characters, and the last digit is the modulo check character.

1.2.1.2 Code Format

The Version A code format is as follows:

SXXXXX XXXXXC

where:

S = number system character
X = additional information characters
C = modulo check character

Number Systems/Applications:

Number System Character	Specified Use
0[1]	Regular U.P.C.'s (source-marked products)
2	Random-weight items, such as meat and produce
3[2]	National Drug Code in current 12-digit code length Note that the symbol is not affected by the various internal structures possible with the NDC
4	For use without code format restrictions and with check digit protection for in-store marking
5	For use on coupons
6,7	Regular U.P.C.'s (source-marked products)
1,8,9	Reserved for uses unidentified at time of this writing

[1]Number system 0 is also used for Version E.
[2]Remember that when using a 10 digit national drug code as a U.P.C. number that the 10 digit NDC becomes a 12 digit U.P.C. with the number system character of 3 and the check digit. The full 12 digit number identifies the product and should be listed and reported this way.

The human readable character identifying the encoded number system will be shown in the left margin of the symbol as per Figure I-1 and Drawings I-2 through I-4.

1.2.2. Version E

1.2.2.1 General Description

Version E or the zero suppressed version of the symbol is included to facilitate source symbol-marking on packages that would otherwise be too small to include a symbol. This is achieved by encoding the symbol in a special way (described in Section 1.3.3) that leaves out some zeros that can occur in the U.P.C. code. For example, code 0 12300 00045 would be encoded in a symbol as 123453, effectively eliminating half of the area that would otherwise be required for the symbol (see drawing I-4).

1.2.2.2 Code Format

The Version E code format is as follows:

XXXXXX[3]

[3]Although explicit in the human readable form, the number system character zero is implicit in the bar code representation. Similarly, the modulo check character is implicitly encoded.

1.3 U.P.C. Symbol General Characteristics and Structures

1.3.1. General

The standard symbol (a machine-readable version of the U.P.C. and other compatible codes) is in the form of dark bars of different widths separated by light spaces of different widths, and a human-readable representation of the bar code in an easy to read font such as OCR-B; hereinafter referred to as the "bar code symbol."

The basic characteristics of the machine-readable character structure are as follows (see Figures I-1 and I-2):

- Each character or digit of a code is represented by two dark bars and two light spaces.

- Each character is made up of seven data elements; a data element hereinafter will be called a "module."

- A module might be dark or light.

- A bar may be made up of 1, 2, 3, or 4 dark modules, as shown in Figure I-2.

The basic characteristics of the machine readable symbol are as follows:

- The symbol size is variable within a specified range, to accommodate the ranges in quality achievable by the various printing processes. That is, it can be uniformly magnified or reduced from the nominal size (defined later in this document) without significantly affecting the degree to which it can be scanned. As a general rule, larger is better when symbol size is being specified.

- The symbol is "wandable," which means a simple hand held device can be used to scan or read the symbol.

- Fixed-position scanners are built to scan this symbol in an omnidirectional manner; that is, automatically read by a scanner when the symbol is drawn past the scanner in any orientation.

- Symbol tampering is readily detectable by scanning devices since the symbol has multiple error-detecting features. These allow scanner designers to build equipment to automatically detect and reject very poorly printed symbols or symbols that have been tampered with.

- The symbol also incorporates and presents the code number in a human-readable form for key entry where machine reading is not feasible.

1.3.2. Version Specific Characteristics/ Structure Version A

The Version A symbol consists of the following:

- One information character located in the leftmost position of the symbol, shows which number system a particular symbol encodes. See section 1.2.1.2.

- Ten additional information characters.

- One character, a modulo check character (see Section 1.3.2.4 for details) is located in the rightmost position of the symbol to ensure a high level of reading reliability. (See Figure I-1.)

1.3.2.1 Geometry

The Version A symbol normally contains dark bars and light spaces built up with nominal 0.0130-inch modules for the nominal size symbol. (Four characters [1, 2, 7, 8] involve "undersize" or "oversize" bars and spaces. See Drawing I-5.) There are 113 modules in the Version A symbol including nine in the left margin and nine in the right margin as shown in Figure I-1.

When the modules are of nominal size, the Version A symbol (including human-readable characters) will have an area of 1.4984 square inches including the light margins (1.469" wide by 1.020" high). The total symbol, however, may be larger or smaller than nominal, depending on the symbol magnification (see section 1.4.3).

The determination of which modules are light and which are dark is given in Section 1.3.2.3. Starting at the left of the regular symbol following the light margin, the symbol is encoded first with the guard bars described in Section 1.3.2.2. These are followed by a number system character, five U.P.C. characters on the left side of the center bars, the center pattern, the remaining five U.P.C. characters on the right side of the center bars, the modulo-10 check character, the same guard bar pattern on the right side, and the light margin. Individual bar code

characters are easily identified. Each character on the left side of the center bars begins with a light space and ends with a dark bar. Correspondingly, characters on the right side of the center bars begin with a dark bar and end with a light space.

In the descriptions which follow, dark modules are represented by 1's while light modules are represented by 0's. The number of dark modules per character on the left side is always three or five, and the number is always two or four, for characters on the right side. Encoding (number of dark and light modules) is identical for all characters on a given side of the symbol.

1.3.2.2 Quiet Zone/boundary Encodations

The nine module wide left and right light margins, also known as quiet zones, are identified in Figure I-1.

The first two bars at the left of the symbol and last two bars at the right of the symbol comprise the left and right guard bar positions, encoded 101.

The bars in the center comprise the fixed center bar pattern, encoded 01010.

1.3.2.3 Character Encodation

The encodation of the left and right halves of the Version A symbol is given in the following chart. Note that the left-hand characters always use an odd number (three or five) of modules to make up the dark bars, whereas the right-hand characters always use an even number (two or four). This provides an "odd" and "even" parity encodation for each character and is important in creating, scanning and decoding a symbol.

Decimal Value	Left Characters (odd parity)	Right Characters (even parity)
0	0001101	1110010
1	0011001	1100110
2	0010011	1101100
3	0111101	1000010
4	0100011	1011100
5	0110001	1001110
6	0101111	1010000
7	0111011	1000100
8	0110111	1001000
9	0001011	1110100

1.3.2.4 Check Character Calculation

Digit positions are numbered from right to left in this algorithm so that the check digit position counts as position 1 and the number system character counts as position 12. For example, the U.P.C. number 012345-011238 would break out as:

Position	12	11	10	9	8	7	6	5	4	3	2	1
	(number system character)											(check digit)
	0	1	2	3	4	5	0	1	1	2	3	8

Follow these steps to calculate the check digit:

Step 1: Starting from position 2 of the number, add up the values in even numbered positions.

For the example:
$$3 + 1 + 0 + 4 + 2 + 0 = 10$$

Step 2: Muliply the result of step 1 by 3.

For the example:
$$10 \times 3 = 30$$

Step 3: Starting from position 3 of the number, add up the values of the digits in odd-numbered positions.

For the example:
$$2 + 1 + 5 + 3 + 1 = 12$$

Step 4: Add up the results of steps 2 and 3.

For the example:

$$30 + 12 = 42$$

Step 5: The check digit is the smallest number that when added to the result obtained through step 4 gives a number that is a multiple of 10.

For the example:

$$42 + X = 50 \text{ (multiple of 10)}$$
$$X = 8$$

8 is the number that when added to 42 results in a multiple of 10. Therefore, the check digit is 8.

The human readable character identifying the encoded check character will be shown in the right-hand margin of the symbol as per Figure I-1 and Drawings I-2 through I-4.

Note: If this algorithm is used to calculate the check digit for a U.P.C. number, the result will be the same as using the check digit algorithm found in other UCC publications. The advantage of this method is that it can also be used to calculate check digits for EAN numbers.

1.3.2.5 Human Readable Representation

A clearly legible font, such as OCR-B, shall be used for printing the human-readable form of the code including the number system character and modulo check character.

For a nominal size Version A, the following is recommended for locating the number system and check digit characters relative to the left and right guard bars respectively:

- Reduce the size of the number system and check digit characters to a maximum character width of .052 inch (4 nominal module widths) and a height that is proportional to the modified width.

- Position the right hand side of the number system .065 inch (5 nominal module widths) to the left of the leftmost guard bar and position the left hand side of the check digit .065 inch right of the rightmost guard bar.

- Position the digits vertically so that the bottoms of the number system and check digit are even with the bottom edge of the remaining full size digits.

Note: If the N for National Drug Code is used, it should be reduced by the same factor as the number system and placed .012 inch above the number system character.

It is recognized that certain printing processes will find it difficult to create human readable representations of the smaller size Number System and Check Digit representations. Any reasonably legible substitution of nominal characters in these locations, that does not adversely affect symbol omni-directionality, will be acceptable.

See Figure I-1 and Drawings I-2 through I-4.

1.3.3 Version Specific Characteristics Version E

The Version E symbol consists of the following:

- Six explicitly encoded information characters.

- One modulo check character (see Section 1.3.2.4) that is implicitly encoded via the parity patterns of the explicit characters.

- One implicit number system character of 0 (zero).

1.3.3.1 Geometry

This version (see Drawing I-4) is similar to the portion of Version A (regular symbol) to the left of the center except as noted in Sections 1.3.3.2 and 1.3.3.3.

1.3.3.2 Quiet Zone/Boundary Encodations

The quiet zone is similar to that of the Version A symbol (Section 1.3.2.2) except that the right hand quiet zone is 7 modules wide. (See Drawing I-4) It has a right guard pattern which is encoded 010101.

1.3.3.3 Character Encodation

Character encodation of the Version E symbol is as given in the following chart:

Three of the characters are coded in odd parity and three are in even. Character encodation for **this version (E) only** is given in the following chart.

Character Value	Odd Parity (O)	Even Parity (E)
0	0001101	0100111
1	0011001	0110011
2	0010011	0011011
3	0111101	0100001
4	0100011	0011101
5	0110001	0111001
6	0101111	0000101
7	0111011	0010001
8	0110111	0001001
9	0001011	0010111

Note that the even parity encodation is different for Version E than for Version A.

The coding for the zero-suppression version (Version E) is compressed into six characters of varying parity. The determination of whether a character's parity is even or odd, is related to the value of the check digit character from the Version A symbol that is implicitly encoded in the symbol parity pattern per the following chart:

Modulo Check Character Value	Character Location Number					
	1	2	3	4	5	6
0	E	E	E	O	O	O
1	E	E	O	E	O	O
2	E	E	O	O	E	O
3	E	E	O	O	O	E
4	E	O	E	E	O	O
5	E	O	O	E	E	O
6	E	O	O	O	E	E
7	E	O	E	O	E	O
8	E	O	E	O	O	E
9	E	O	O	E	O	E

The six explicit characters are derived from the U.P.C. code as follows:

- If a manufacturer's number ends in 000, 100 or 200, he has available to him 1,000 item numbers between 00000 and 00999. The six characters are obtained from the first two characters of the manufacturer's number (excluding the number system character of zero[4]) followed by the last three characters of the item number, followed by the third character of the manufacturer's number.

- If a manufacturer's number ends in 300, 400, 500, 600, 700, 800, or 900, he has available to him 100 item numbers between 00000 and 00099. The six characters are obtained from the first three characters of the manufacturer's number (exclusing the number system character of zero[4]) followed by the last two characters of the item number, followed by "3."

- If a manufacturer's number ends in 10, 20, 30, 40, 50, 60, 70, 80, or 90, he has available to him 10 item numbers between 00000 and 00009. The six characters are obtained from the first four characters of the manufacturer's number (excluding the

number system character of zero[4])followed by the last character of the item number, followed by "4."

- If a manufacturer's number does not end in zero, then five item numbers between 00005 and 00009 are available. The six characters are obtained from the five characters of the manufacturer's number (excluding the number system character of zero[4]) followed by the last digit of the item number.

[4]*Important Note: Only number system "0" can be represented by zero suppression Version E symbols.*

1.3.3.4 Check Character Calculations

There is no explicit character encodation for the modulo check character. Its value is derived from the parity permutation of the six encoded characters.

An example may be helpful. Assume code number 0-12300-00064. First compute the modulo check character as detailed in Section 1.3.2.4.

Step 1: 4 + 0 + 0 + 0 +2 + 0 = 6

Step 2: 6 x 3 = 18

Step 3: 6 + 0 + 0 + 3 + 1 = 10

Step 4: 18 + 10 = 28

Step 5: Modulo check character is 2
(30 - 28)

Now select the parity combination from the Zero-Suppression Parity Pattern (EEOOEO from the table on page I-6). Finally use this parity pattern and the decision rules from the preceding page to encode the symbol; i.e., left hand guard bars (101), EVEN1, EVEN2, ODD3, ODD6, EVEN4, ODD3, right hand guard bars (010101).

1.3.3.5 Human Readable Representation

Font recommendations are detailed in Section 1.3.5 for the Version A symbol. For Version E (nominal size), utilize the same size number system and check character as recommended for Version A. Position the right hand side of the number system .065 inch to the left of the leftmost guard bar. Position the right hand side of the check digit tangent with the right hand crop mark. This would make the spacing between the left edge of the check digit and the right edge of the rightmost guard bar a minimum of .039 inch. Align the bottom edges of all characters as recommended for Version A.

It is recognized that certain printing processes will find it difficult to create human readable representations of the smaller size Number System and Check Digit representations. Any reasonably legible substitution of nominal characters in these locations, that does not adversely affect symbol omni-directionality, will be acceptable.

1.4 U.P.C. Symbol/Character Dimensional Specifications

1.4.1 Typical Overall Symbol Geometry

1.4.1.1 Version A

Drawings I-1 to I-3 provide overall dimensional specifications for a 100% nominal size Version A symbol (.013" module width). Note Appendix B for English/metric conversion.

1.4.1.3 Version E

Drawing I-4 provides overall dimensional specifications for a 100% nominal size Version E symbol (.013" module width). Note Appendix B for English/metric conversion.

1.4.2. Nominal Character or Guard Bar Configuration and Dimensions

1.4.2.1 Version A

Drawing I-5 provides boundary and data character encodation and dimensional specifications for a 100% nominal size Version A symbol (.013" module width). Note in particular the modified (bit shaved) dimensions for characters 1, 2, 7 and 8. Note Appendix B for English to metric conversion.

1.4.2.2 Version E

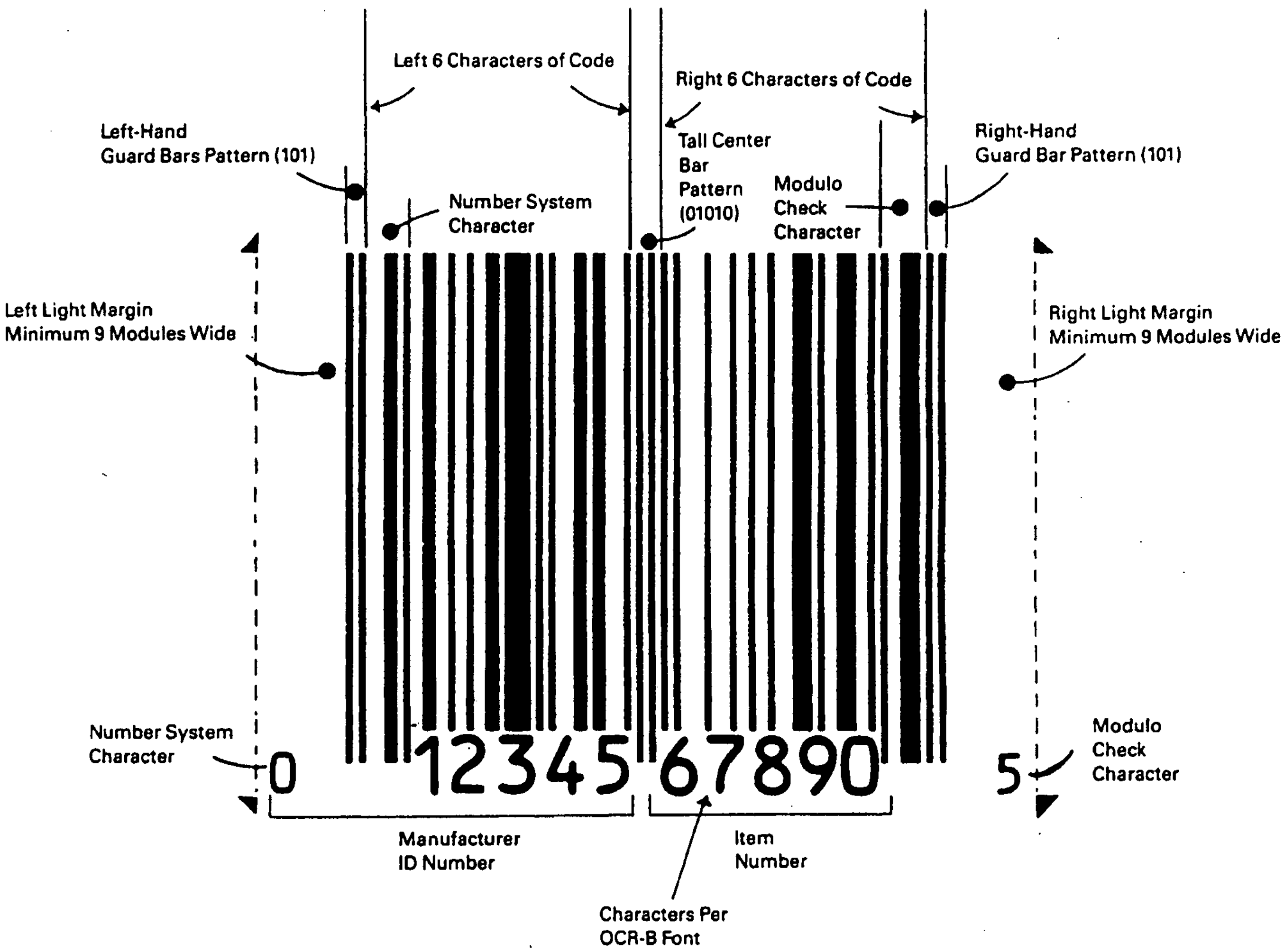
Drawing I-6 provides boundary and data character encodation and dimensional specifications for a 100% nominal size Version E symbol (.013" module width). Note in particular the modified (bit shaved) dimensions for characters 1, 2, 7 and 8. Note Appendix B for English to metric conversion.

1.4.3 Symbol Magnification

The symbol has been designed so that it can be uniformly varied in size over a wide range.The allowable magnification varies from 0.8 to 2.0 times the nominal dimensions shown in Drawing I-1 through I-6 (See Appendix C). This effectively allows for the use of a smaller symbol where packaging considerations dictate or when printing factors normally permit accurate printing, and for use of a larger size where packaging and considerations allow this or less accurate printing conditions prevail.

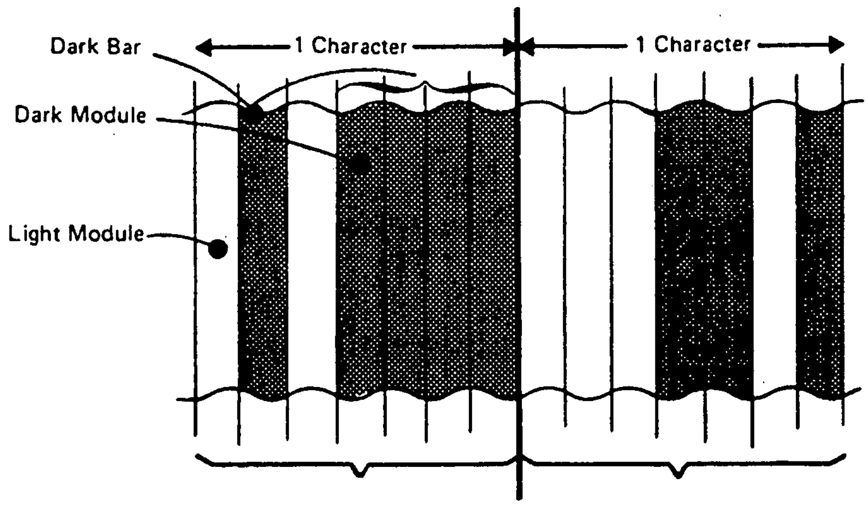
As a general policy, **larger is better** since printing accuracy is less restrictive and scanner performance improves. Magnification up to the maximum permitted is encouraged wherever packaging considerations will allow.

Figure I-1 U.P.C. Standard Symbol



(NOT TO SCALE)

Figure I-2 Character Structure



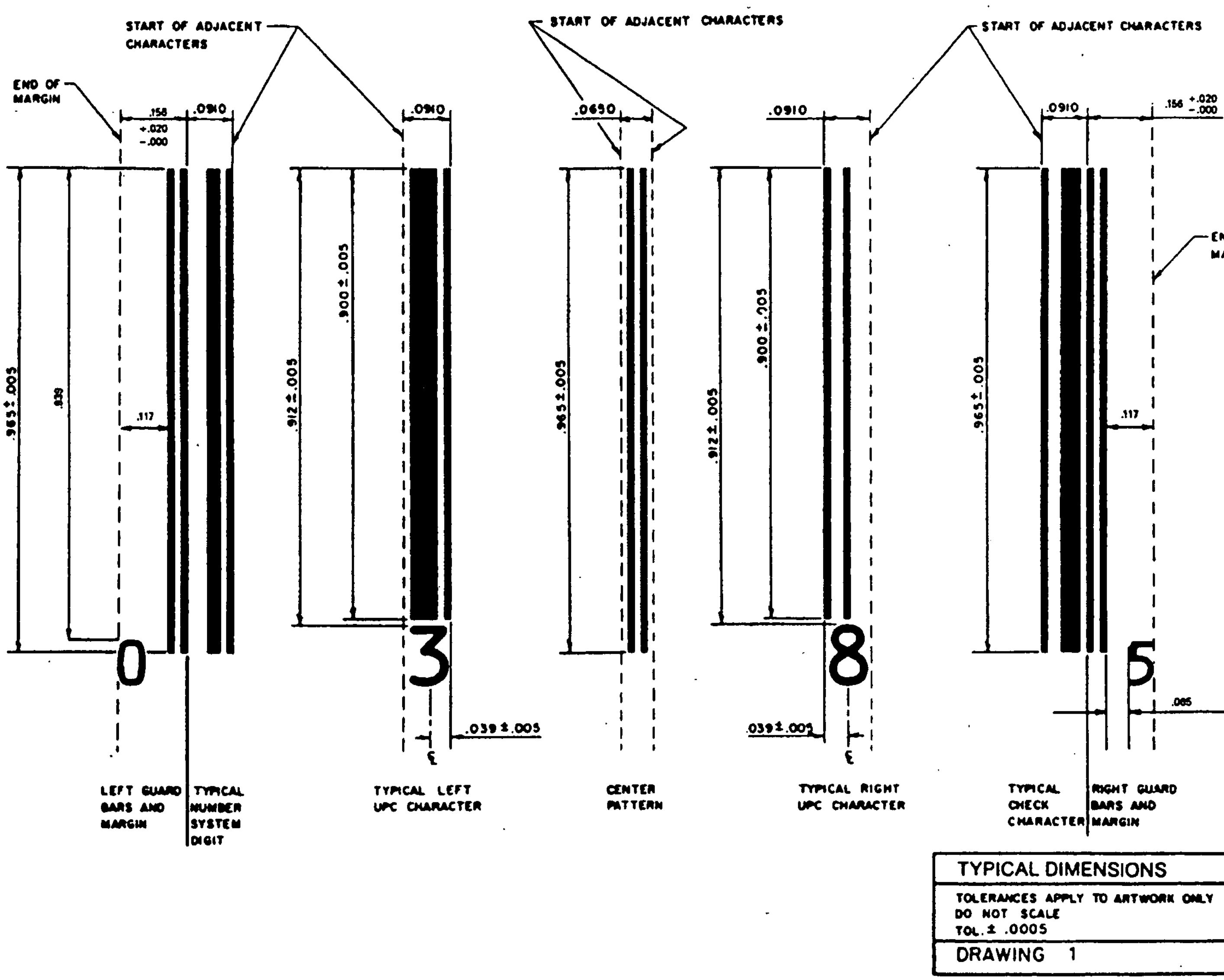
7 Modules
2 Bars/2 Spaces

The Above
Character
Represents a
Left-Hand "6"
Which is
Encoded 0101111

7 Modules
2 Bars/2 Spaces

The Above
Character
Represents a
Left-Hand "0"
Which is
Encoded 0001101

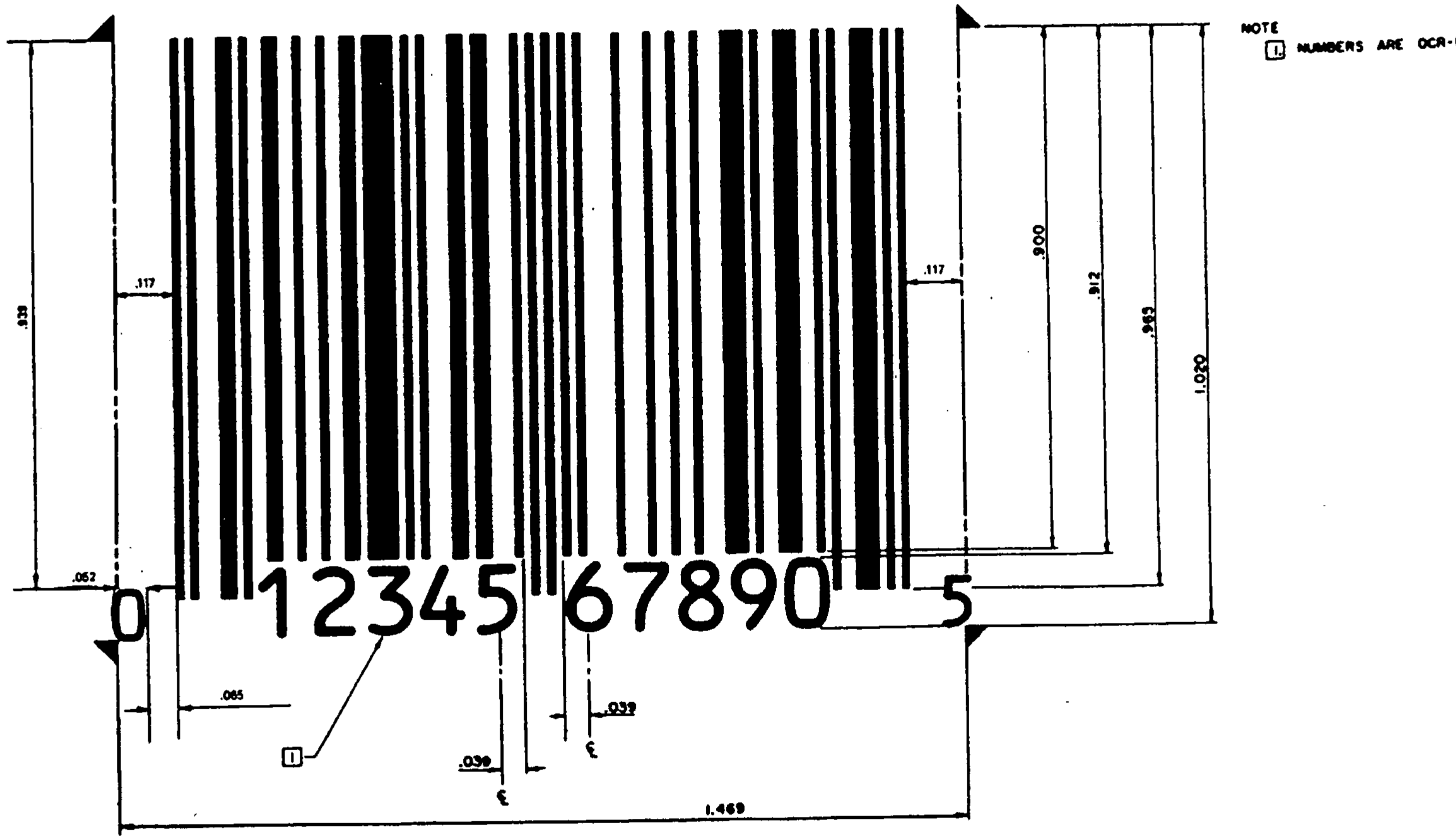
Drawing I-1 Typical Dimensions



CORRECTED NOVEMBER 1985

NOTE: ALL DIMENSIONS IN INCHES AND BASED ON 100% NOMINAL SIZE.

Drawing I-2 Reference Drawing for U.P.C. Symbol

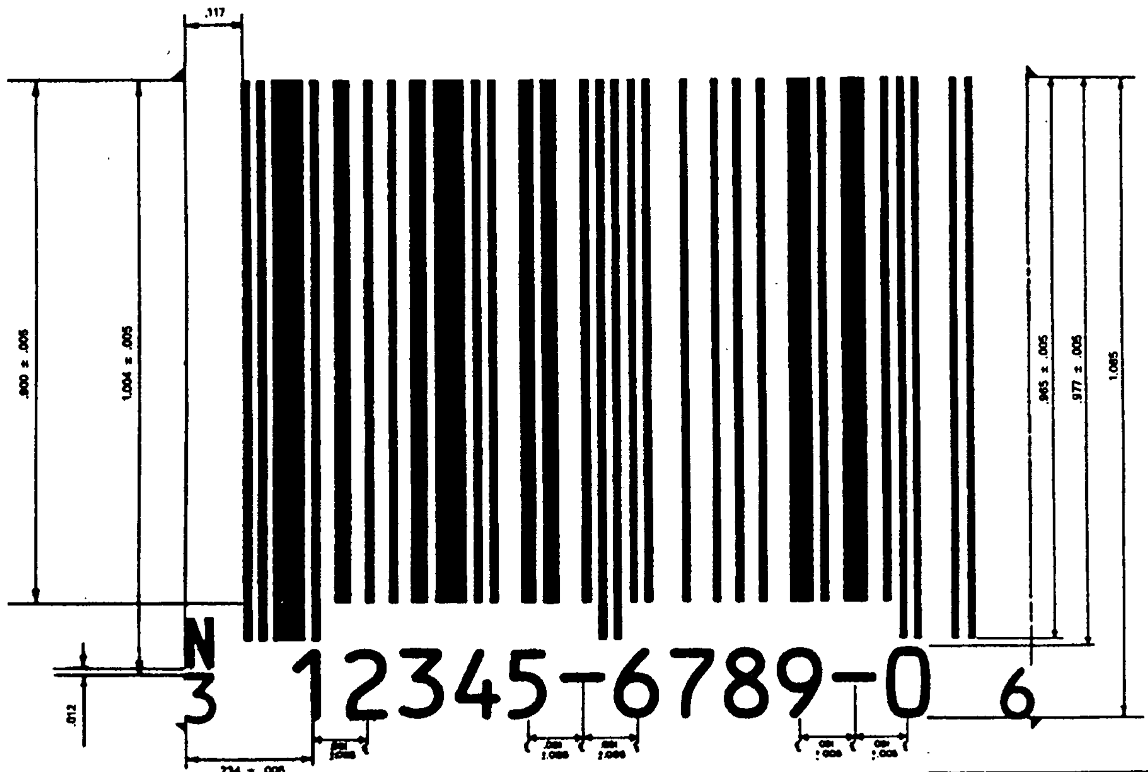


NOTE: ALL DIMENSIONS IN INCHES AND BASED ON 100% NOMINAL SIZE.

REFERENCE DRAWING FOR UPC SYMBOL
ALL DIMENSIONS EXCEPT WHERE NOTED ARE FOR REFERENCE ONLY DO NOT SCALE
DRAWING 2

CORRECTED NOVEMBER 1985

Drawing I-3A Regular NDC Symbol

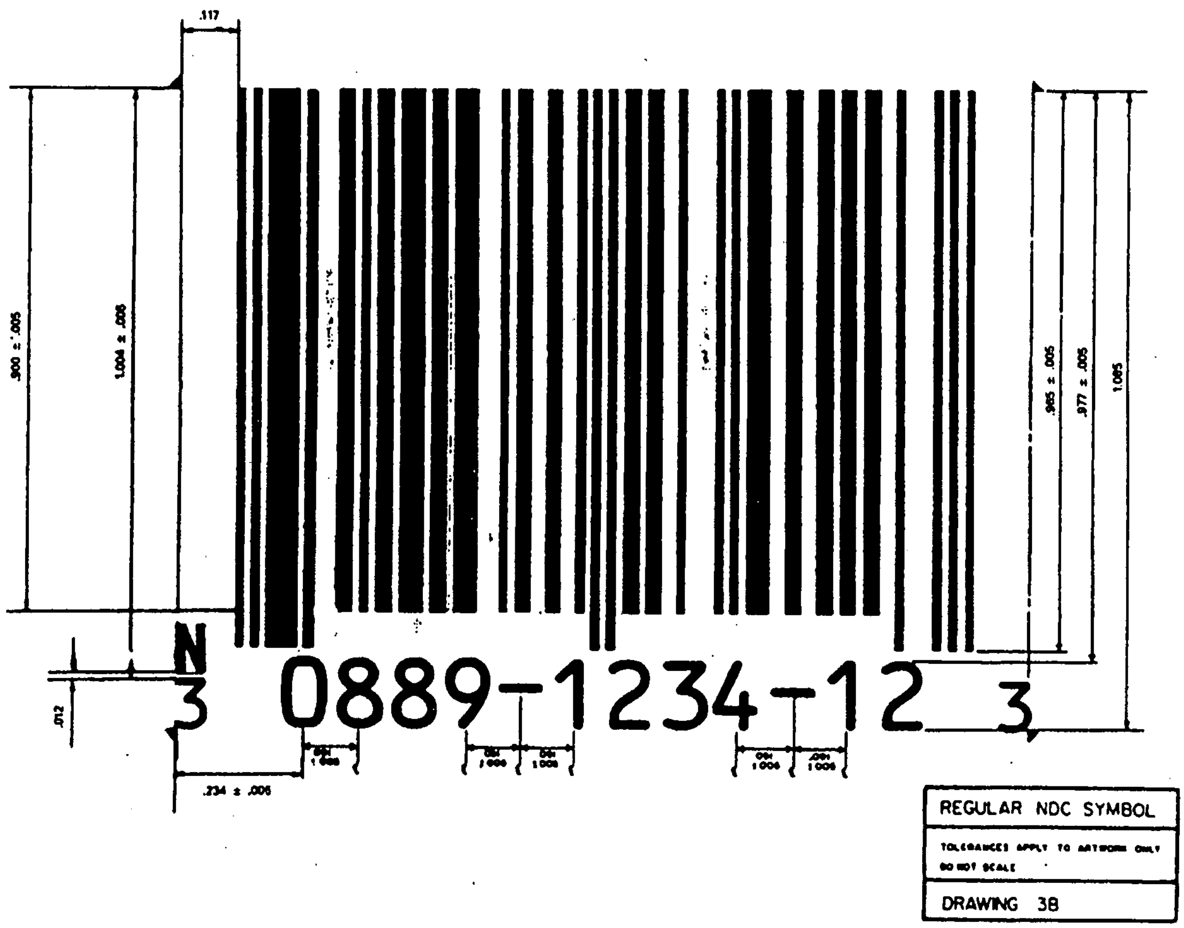


REGULAR NDC SYMBOL
TOLERANCES APPLY TO ARTWORK ONLY DO NOT SCALE
DRAWING 3A

CORRECTED NOVEMBER 1985

NOTE: ALL DIMENSIONS IN INCHES AND BASED ON 100% NOMINAL SIZE.

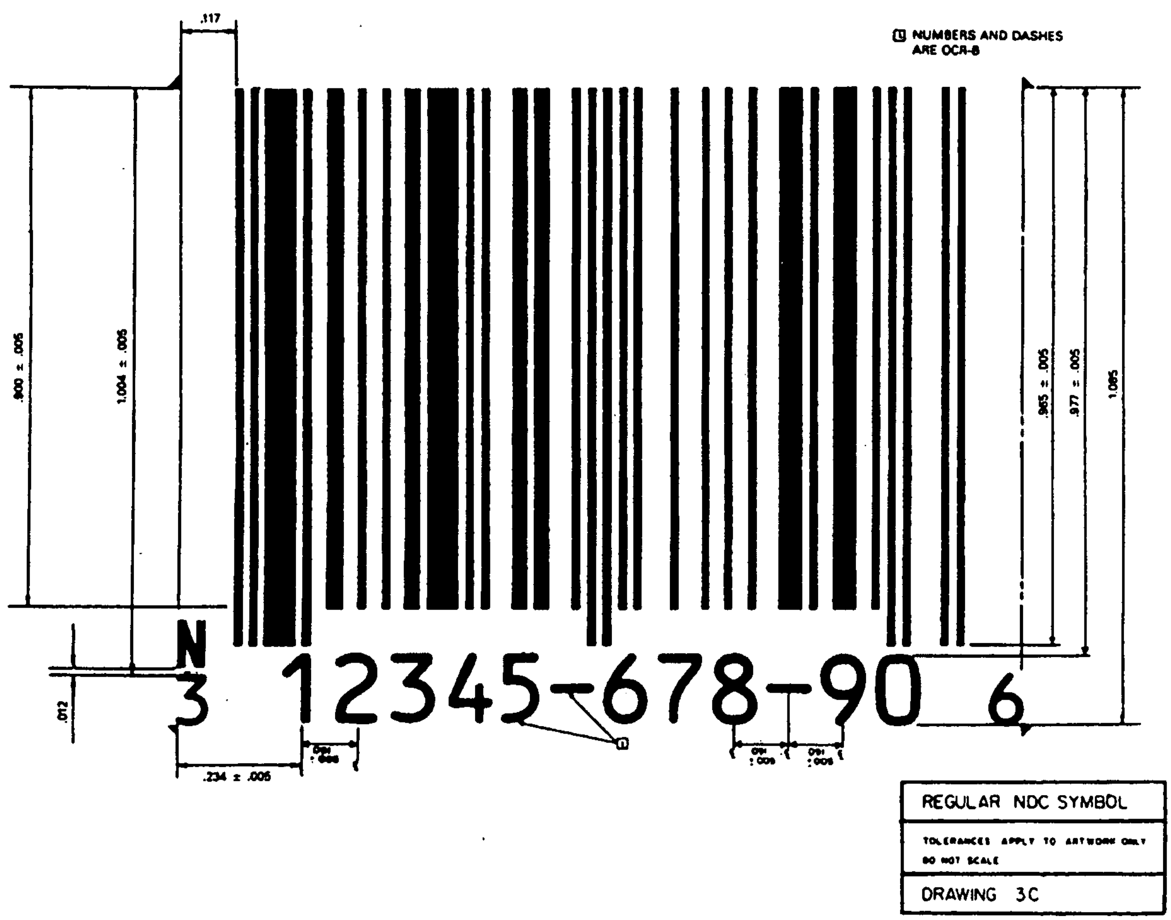
Drawing I-3B Regular NDC Symbol



CORRECTED NOVEMBER 1985

NOTE: ALL DIMENSIONS IN INCHES AND BASED ON 100% NOMINAL SIZE.

Drawing I-3C Regular NDC Symbol

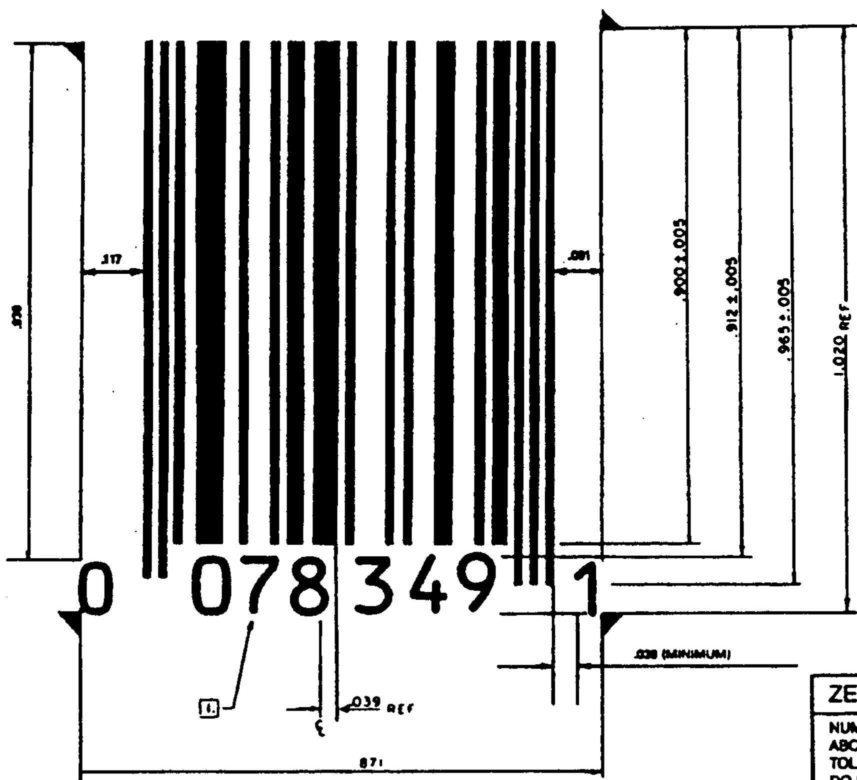


CORRECTED NOVEMBER 1985

NOTE: ALL DIMENSIONS IN INCHES AND BASED ON 100% NOMINAL SIZE.

Drawing I-4 Zero Suppression Symbol

NOTE
1. NUMBERS ARE OCR-B

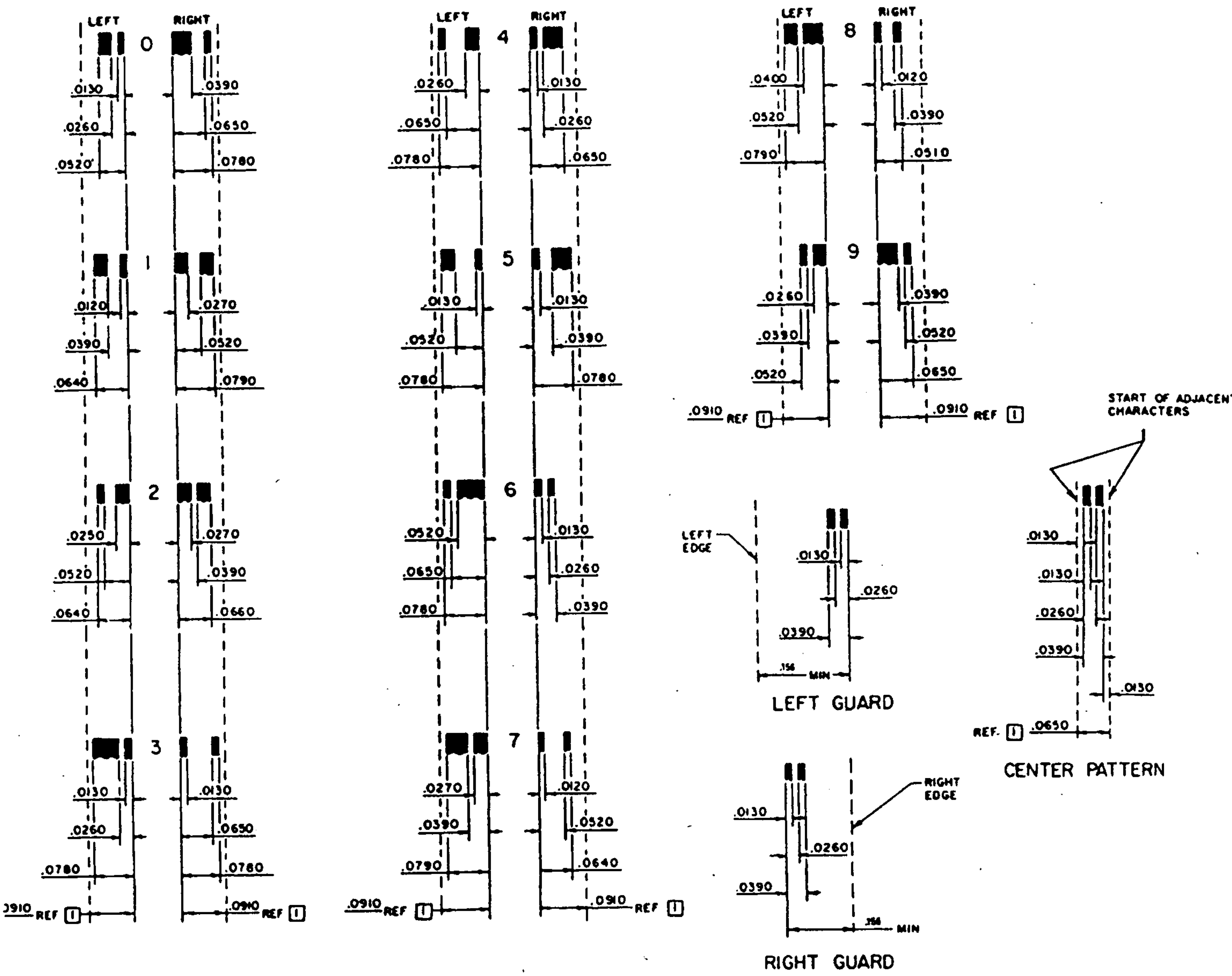


ZERO SUPPRESSION SYMBOL
NUMBER SYSTEM 0 ABOVE SYMBOL REPRESENTS 07834-00009 TOLERANCES APPLY TO ARTWORK ONLY DO NOT SCALE
DRAWING 4

CORRECTED NOVEMBER 1985

NOTE: ALL DIMENSIONS IN INCHES AND BASED ON 100% NOMINAL SIZE.

Drawing I-5 Encodation Chart Regular Symbol

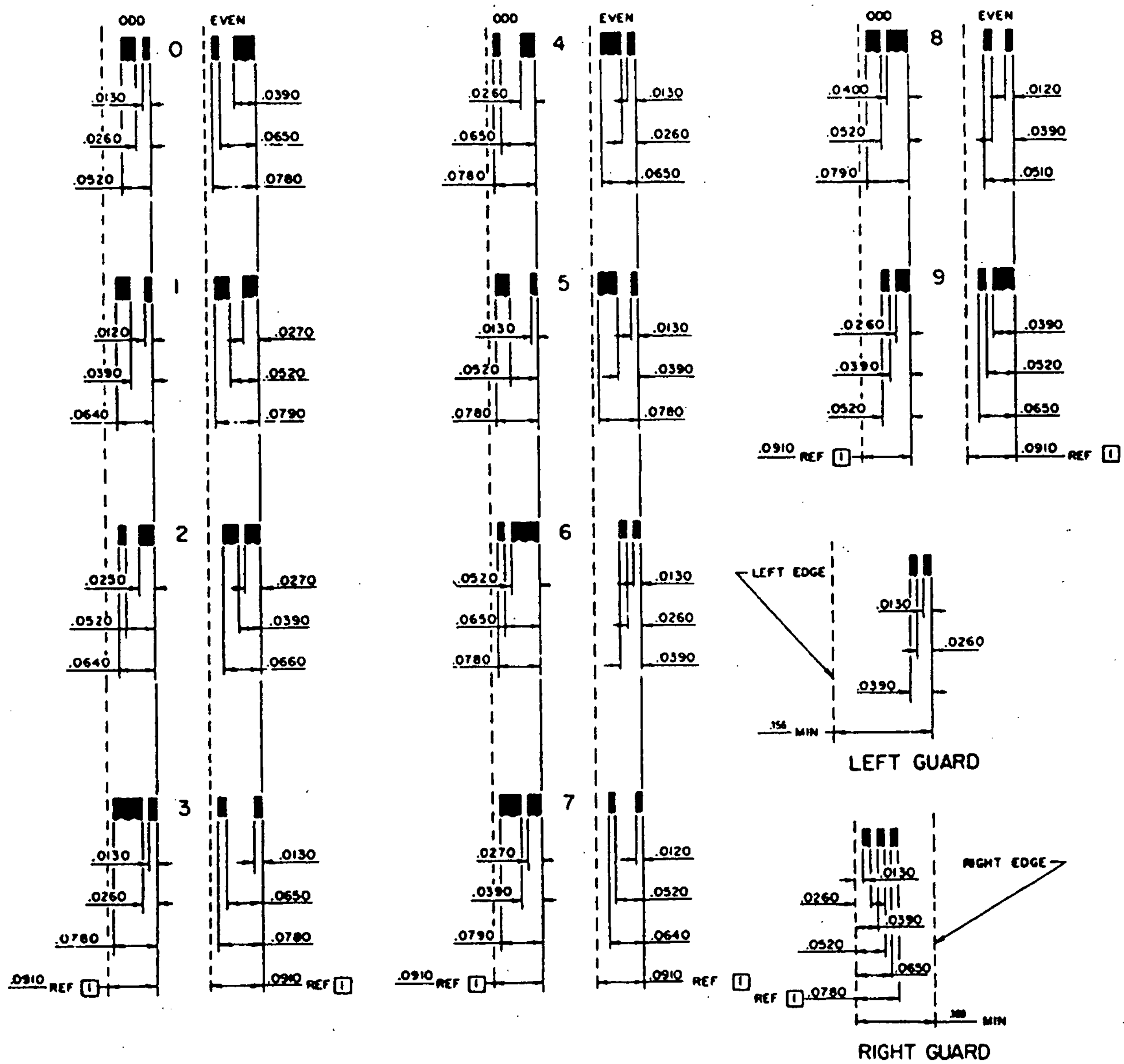


ENCODATION CHART REGULAR SYMBOL
DO NOT SCALE FILM MASTER TOLERANCES ± .0002 EXCEPT WHERE OTHERWISE REFERENCED TO NOTE [1]
DRAWING 5

CORRECTED FEBRUARY 1975

NOTE
[1] TYPICAL WIDTH OF ONE CHARACTER TOLERANCE IS ± .0005

Drawing I-6 Encodation Chart Zero Suppression Symbol



ENCODATION CHART ZERO SUPPRESION SYMBOL
DO NOT SCALE FILM MASTER TOLERANCES ± .0002 EXCEPT WHERE OTHERWISE REFERENCED TO NOTE [1]
DRAWING 6

CORRECTED FEBRUARY 1975

NOTE

[1] TYPICAL WIDTH OF ONE CHARACTER
TOLERANCE IS ± .0005

Part II U.P.C. Verifier User

2.1 Purpose/Scope

U.P.C. Verifier User: The intent of this section is to provide information for the non-technical user of verifier equipment. The presentation is qualitative and intuitive, in contrast to Part III which is technically rigorous. In the event that any aspect of this section seems ambiguous or is inconsistent with Part III, Part III takes precedence.

2.2 Measurement Methodology — An Overview

2.2.1 The Scanner/Verifier

The productivity of automated point-of-sale systems depends on the ability to quickly and accurately scan U.P.C. symbols on merchandise. Compliance with the *U.P.C. Symbol Location Guidelines* will help assure that the symbol is easily found, and that the packaging configuration will not interfere with any of the *Quality Specification for the U.P.C. Printed Symbol's* parameters.

The speed and ease at which a scanner reads the U.P.C. depends on the quality of the printed symbol, scanner capability and maintenance, and operator technique. Retailers or other users of the bar code can select and maintain their scanners and train their operators, but must rely on suppliers to provide good U.P.C. symbols on merchandise.

Much can be learned about a U.P.C.'s acceptability for your application before a decision is made to use a verifier. The reader is encouraged to refer to Appendix F for a brief overview of this subject.

This specification for verifying, and a verifier designed to this standard, provide uniform tools for grading the quality of U.P.C. symbols. A verifier should be able to predict successful scans on virtually all types of properly maintained retail scanners. However, a symbol that receives a failing grade may or may not scan satisfactorily with a specific scanner.

2.2.2 Bar Code Scanning

When people look at a bar code symbol they see a series of alternating dark and light stripes of varying width. On the other hand, a scanner *sees* the bar code quite differently.

Imagine a country road with a series of tall tree trunks outlined against the sky. You could think of the dark trees as bars and the light blue sky as spaces in a bar code symbol. Imagine you are riding in a vehicle with the late afternoon sun shining from behind the trees. When you face the trees with your eyes closed, you perceive an intense flickering light, even though you cannot actually see the row of trees.

In a similar fashion, scanners perceive a bar code as a flickering light. We can represent the flickering light seen by a scanner in graphical form as shown in Figure II-1.

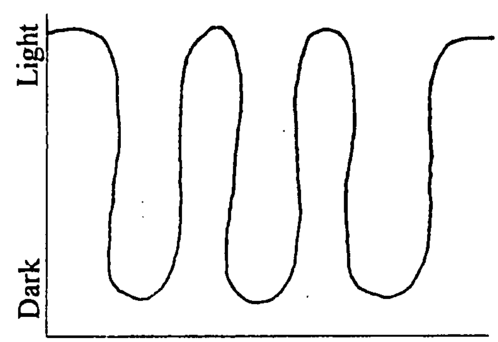


Figure II-1: Reflectivity Measurements

Verifiers are designed to see the bar code symbol in a manner similar to that of a scanner. Each time the verifier looks at a symbol it obtains a scan reflectance profile (SRP) which resembles Figure II-1 (or more precisely, Part III, Figure III-2). The verifier then analyzes the scan reflectance profile through the use of a series of reference reflectivity measurements, to obtain a quality grade (0 through 4). Several profile grades (ten are recommended) are

averaged to obtain a numerical score for the symbol. Printers are strongly encouraged to maintain their systems so that they will consistently produce good or excellent bar code symbols with quality scores above 2.5. The minimum acceptable score is 1.5 when the symbol is in its final packaged form.

2.2.3 Verifying U.P.C. Symbols

The Verifier: Instruments designed to verify the U.P.C. symbol must conform to the requirements of Part III. Evidence of a verifier's compliance with an industry standard designed to ensure National Institute of Standards and Technology (NIST) traceability of symbol measurements, should be provided with each instrument.

Each model of verifier should be calibrated and operated according to the manual provided by its manufacturer. A set of test symbols, or secondary standards, developed by the industry can be a valuable tool for verifier user training and confidence testing.

Verifier designs, quite possibly, differ in their ability to evaluate certain attributes required by this specification. For example, Magnification may be calculated by some while others will require the manual measurement of this parameter. In the future, technology advancements and innovation may further automate the measurement of parameters, such as, truncation.

It could be advantageous to the user if a verifier groups the presentation of all attributes required by this specification. Ease of use could benefit from this approach. This should, however, not discourage the evaluation of additional characteristics of the U.P.C. symbol, which may add valuable diagnostic capabilities to an instrument.

2.2.3.1 Scan Reflectance Profile (SRP)

Each scan reflectance profile or single scan path is evaluated by the verifier according to the nine attributes or parameters. Five of these attributes are subject to pass/fail criteria, where a failure scores 0 (F) and a pass scores 4 (A). Each of the remaining four attributes are graded:

4 (A) Superior
3 (B) Good
2 (C) Satisfactory
1 (D) Unsatisfactory
0 (F) Poor

The overall grade for the scan reflectance profile or single scan path is the lowest grade for any of the nine attributes.

2.2.3.2 Overall Symbol Grade

The formal verification of a U.P.C. symbol requires ten scan reflectance profiles spaced with reasonable uniformity along the symbol as suggested in Figure II-2 (or more precisely in Part III, Figure III-1). Diagonal scans are also acceptable.

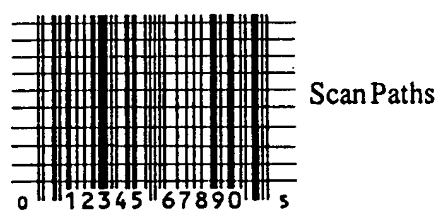


Figure II-2: Paths of Scan Reflectance Profiles

An informal estimate of symbol quality may be based on a smaller number of scan reflectance profiles. The overall symbol grade is obtained by averaging the grades of the individual scan reflectance profiles.

2.2.3.3 Assuring Symbol Quality

Verification is particularly useful for quality assurance of the symbol printing process. It can also assure that symbol contrast, quiet zone specifications, etc., are not degraded to an unacceptable degree by its placement in a packaging environment (overwrap, showthrough, etc.).

A verifier is useful when used to monitor and control the symbol printing process. If a symbol fails verification, the user will know to obtain higher

quality supplies, or clean, adjust or repair the printing equipment. If a symbol gets low but still passing grades, detailed data from the verifier will offer clues to improve the symbol's quality.

Operators of printing equipment and those concerned with environmental factors that affect symbol quality, should understand the various attributes of quality explained in Section 2.2.4.

2.2.3.4 The Verifier in Various Roles

Verifiers designed and manufactured in compliance with this specification may vary in a number of ways. The optical scanning method employed to produce the SRP, attribute measurement precision, and special features designed to further diagnose U.P.C. problems, are a few examples.

Some valid factors to consider when choosing a verifier are: The substrate on which the symbol will be printed, the user's measurement precision needs, the skill level of the user, and cost.

2.2.4 The SRP Parameters — Attributes of Quality

The nine attributes which affect the grade of a scan reflectance profile consist of: Edge Determination, Minimum Reflectance (R_{min}), Symbol Contrast (SC), Minimum Edge Contrast (EC_{min}), Modulation (MOD), Defects, Quiet Zone (QZ), Decode, and Decodability. As a general rule, all measurements of a symbol should be made with the U.P.C. in its final packaging environment or equivalent as discussed in Appendix F. The nine attributes and their relationship to the printing process are discussed next.

2.2.4.1 Edge Determination

When the verifier is unable to find an appropriate number of bars and spaces as specified in Part I, it reports a global threshold or edge determination failure. In this case, the profile receives a grade of 0 (zero). Otherwise, the grade for this attribute is 4. The verifier must find 59 elements (30 bars and 29 spaces) for a version A symbol and 33 elements (17 bars and 16 spaces) for a version E symbol.

There are several reasons why a symbol may appear to have too many or too few elements. Excessive bar growth (ink spread) may cause the smaller spaces to become so narrow that the verifier can no longer see them. In this case, the verifier would report fewer than 59 elements (for a Version A symbol). A different reason for failure is when one of the narrow bars is so weakly printed that the verifier cannot see it, resulting in 57 elements for a Version A symbol. The opposite type of failure occurs when large defects as shown in Figure II-3 cause the verifier to find too many elements.

Symbols with edge determination failure may be examined with a magnifier to reveal the underlying problem. When fewer than 59 elements (33 for Version E) are reported, look for excessively thin spaces or weakly printed narrow bars. When more than the correct number of elements are found, the most likely cause is the presence of large defects, predominantly voids. Because the verifier thinks that very large defects are additional elements rather than defects, such outsized defects will have no effect on the defect grade. Profiles which fail edge determination will, of course, receive an overall profile grade of 0 (F).

2.2.4.2 Minimum Reflectance (R_{min})

The darkest bar must have a reflectance less than half of the background. This attribute is judged on a pass/fail basis. A failing grade for minimum reflectance will most often indicate that the bars should be printed darker or in a color that appears darker under red light.

2.2.4.3 Symbol Contrast (SC)

The blackest possible bars printed on the whitest possible surface would have a 100% contrast. Practical printing of the U.P.C. symbol on commercial materials results in less than 100% contrast. When the contrast becomes too low, scanners may

have difficulty distinguishing the bars from the spaces; thus, higher contrast is desirable. Symbol contrast is graded 0 through 4, according to Section 3.5.2.3. All measurements are taken with red light, as explained in Part III.

A low contrast grade indicates that either the bars are too light (not enough ink or ink not dark enough), the background is too dark, or both. Because the measurements are made with red light, it can be informative to visually inspect the symbol through a red transparency. When viewed in this fashion, the bars should appear to be much darker than the spaces. Generally speaking, the background (spaces) should be white or one of the warm colors (red, orange, yellow) and the bars should be black, brown, blue or green.

2.2.4.4 Minimum Edge Contrast (EC_{min})

The attribute of minimum edge contrast is graded on a pass/fail basis. A failing grade for minimum edge contrast will always be accompanied by low (0 or 1) grades for symbol contrast, modulation, or both.

2.2.4.5 Modulation (MOD)

Scanners and verifiers perceive the narrow (1 module) spaces to be less white than the wide (2, 3, or 4 module) spaces. Similarly, but to a lesser extent, the narrow bars in a symbol look less black than the wide bars. This diminished intensity of narrow elements as compared to that of wide elements is called modulation.

Modulation is graded 0 through 4, according to Section 3.5.3. The most probable reason for a low (0 or 1) modulation grade is ink spread, which reduces the width and intensity of the single module spaces within the symbol.

2.2.4.6 Defects

Printing defects are of two types, voids and spots. Voids are light areas within the bars. Spots are dark areas in the spaces. Defects are undesirable because the scanner may become confused and think that a defect is an additional bar or space within the symbol. Defects are illustrated in Figure II-3:

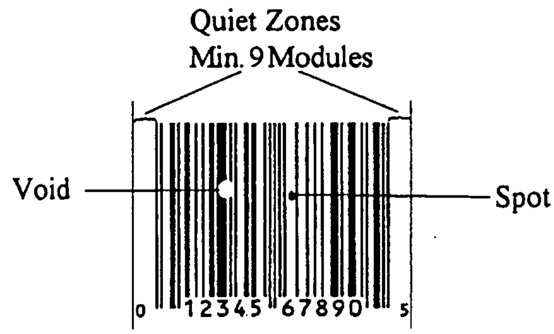


Figure II-3: Defects and Quiet Zones

Defects are graded 0 through 4, according to Section 3.5.4. Symbols which produce profiles with low (0 or 1) defect grades can be examined with a good quality magnifier (5 to 10 power). The defects will be clearly visible. Usually, defects are voids that can be reduced or eliminated by increasing the amount of ink (or equivalent). Less often, excessive pigment or dirt may be deposited in the spaces, with resultant spots or inclusions.

2.2.4.7 Quiet Zone (QZ)

U.P.C. symbol design mandates a quiet zone, or area of uniform light contrast, adjacent to the outer edges of the left and right hand guard bars. Printing in the quiet zone, using overwrap in a manner that affects the restricted area, and placing the symbol near the edge of a package, are common causes for failure to meet quiet zone specifications. A quiet zone that passes minimum width requirements receives a grade of 4; otherwise, the grade is 0.

2.2.4.8 Decode

Dimensional errors in printing a U.P.C. symbol can make it difficult or impossible to scan. A verifier applies specific rules (explained in Part III) to the sequence of bars and spaces to decode them into a series of digits and guard bars. When the verifier is able to decode a symbol including its guard patterns, and when the check digit is consistent with

the other 11 digits, the decode attribute passes with a grade of 4; otherwise, the grade is 0.

If all scan reflectance profiles for a symbol receive passing grades (2 or higher) for the attributes described in section 2.2.4, but fail decode, the symbol is probably incorrectly encoded. It is reasonable to suspect that all or many of the symbols which were created by the same equipment in a similar timeframe may also be defective.

When only one out of several profiles fails to decode, the cause is usually a localized blemish in the symbol that can be spotted with a magnifier.

2.2.4.9 Decodability

Decodability is a graded attribute (0, 1, 2, 3, 4) according to Section 3.5.6, that measures how near the scan reflectance profile is to approaching decode failure. Symbols which are printed to a high degree of dimensional accuracy will exhibit high decodability grades.

One common reason for low decodability grades is ragged, uneven bar edges. This problem, caused by some of the coarser printing processes, is easily observed with a 5 to 10 power magnifier. Another reason for low decodability is excessive bar growth (ink spread), which also tends to adversely affect modulation and edge determination.

The creation of bar codes using an improperly designed graphics based software system is a likely cause of low decodability.

Software used with pixel based printers must scale each bar and space exactly to the pixel pitch of the printer being used. The number of pixels comprising each symbol character must be an integer multiple of the number of modules for each symbol character.

Specifically, the printed part of a U.P.C.-A symbol (between the outside edges of the right and left guard bars) must be an integer multiple of 95 pixels and the printed part of a U.P.C.-E symbol (between the outside edges of the right and left guard bars) must be an integer multiple of 51 pixels.

Any compensation for uniform bar growth or shrinkage, must be in equal or offsetting amounts on all bars and spaces in the symbol.

2.2.5 The Overall Symbol Grade and Impact on Scanning

The overall symbol grade is obtained by averaging the grades of the individual scan reflectance profiles, by adding the grades and dividing by the number of profiles (10).. For example, if the ten individual profile grades were 2, 3, 2, 2, 1, 3, 0, 2, 1, 3; the symbol grade would be 1.9. To be minimally acceptable, a U.P.C. symbol must have a grade of 1.5 or higher. Operators of printing equipment should, however, strive for the highest scores which are reasonably attainable with their particular process and machinery.

Scanning system performance depends on many factors. All components must strive for perfection, since optimum productivity is synonymous with achieving the highest grade levels for all of its parts. In the case of the symbol, a grade of 1.5 can be expected to scan well when subjected to a reasonable environment and when scanned by a well maintained scanning device.

In general, symbols with higher quality grades can be expected to scan more easily and quickly than lower quality symbols of the same magnification. Larger magnification, the absence of truncation, and high print quality, contribute to fast, effortless scanning.

Symbols that fail verification may scan easily under ideal conditions, but badly or not at all in other environments. High productivity is synonymous with high symbol grades. Lower grade levels, although satisfactory, may cause failure to meet productivity goals in less than optimum environments.

2.2.6 Symbol Quality Attributes Not Evaluated by the Verifier

Conformance to those aspects of the *Quality Specification for the U.P.C. Printed Symbol* not measured by the verifier must be determined independently. The following sections discuss these parameters.

2.2.6.1 Truncation/Bar Height

Truncation usually cannot be measured by a verifier. Verifiers are scanning single paths across the symbol and cannot see if a symbol is truncated. Minimum bar heights for various symbol sizes (required to avoid truncation) are specified in Appendices A and C.

Truncation may have a serious impact on a symbol's scannability. See Appendix A for the UCC stance on truncation.

2.2.6.2 Bar Growth Non-Uniformity

A common property of many of the U.P.C. printing processes results in relatively uniform bar width growth or shrinkage across a printed symbol. Some decoders for the U.P.C. symbol take advantage of this property. Attributes defined in this specification, and evaluated by all verifiers, determine the acceptable limits for bar width growth and shrinkage.

It is good practice and it is recommended that U.P.C. printers minimize the percentage change in bar growth from character to character, as well as across an entire symbol. Diagnostic features provided by verifiers may be useful in measuring this property.

Printing with badly aligned flexographic plates is a likely cause of excessive non-uniformity.

2.2.6.3 Magnification

Magnification or symbol size is an important quality attribute that may be reported by some verifiers. Specifications are contained in Appendix C.

As a general policy, **larger is better**. This is further discussed in Section 1.4.3.

2.2.6.4 Human Readable Characters

The placement of human readable characters must provide optimum visible correlation with the U.P.C. symbol. Consistency between the encoded and human readable characters is mandatory. See Part I for details.

Part III U.P.C. Verifier/Printer Designer

3.1 Purpose/Scope

3.1.1 U.P.C. Symbol Verifier Designer

The *American National Standards Institute (ANSI) Guideline for Bar Code Print Quality (X3.182-1990)*, established as a procedure for measuring quality parameters of printed bar code symbols, has been combined with U.P.C. specific requirements. This specification provides the designer of U.P.C. verification devices with detailed guidelines and requirements for the design and development of equipment to measure and evaluate optical characteristics and quality of the printed U.P.C. symbol.

3.1.2 U.P.C. Symbol Printer Designer

This combined ANSI/U.P.C. specification provides detailed quality requirements for the printed U.P.C. symbol. The designer of printing device hardware or software is provided with optical characteristics of the U.P.C. printed symbol that dictate design requirements of the mechanisms that are used to create the U.P.C. printed symbol.

3.2 Measurement Methodology

3.2.1 Verifier Scanner Parameters

The reference measurement methodology contained in this specification is designed to maximize the consistency of both reflectivity and bar and space width measurements of bar code symbols on various substrates. The parameters of verifier scanners used to implement this methodology are designed to correlate with many conditions encountered in U.P.C. bar code scanning hardware.

3.2.1.1 Wavelength

The *U.P.C. Symbol Specification Manual*, first published in 1973, designates a symbol illumination of 633nm. This specification was based on a scanner's use of the helium neon gas laser, the predominant technology at the time. The gas laser continues to be employed in many U.P.C. scanner designs, and remains in widespread use.

The desire for portability of verifiers, and advances in solid state technology, have encouraged the use of light emitting diode and visible laser diode light sources that operate at somewhat longer wavelengths than the gas laser. Scanners using illumination sources in this range, are also becoming increasingly popular.

This specification requires the use of verifiers that operate at wavelengths in the range of 670 +/- 10 nm. Extensive scanner to verifier correlation testing has confirmed that verification at these wavelengths provides grades that are reliable predictors of scanner performance for the vast majority of symbols. In a few cases, however, it may be prudent to do further testing especially where scanners and verifiers employ different wavelengths, and when correlation appears questionable.

It has been noted that some direct thermal printed symbols, or possibly those printed with certain colors of dye based inks, may require further investigation.

Results obtained from a 670nm verifier are expected to correlate with the scanning results from a 670nm scanner. Therefore, if a 670nm verifier grades a particular symbol as having poor or marginal contrast, a 670nm scanner would have difficulty scanning this symbol. Scanners using a 633 nm light source, however, may scan the symbol with ease.

3.2.1.2 Measuring Aperture

U.P.C. verifier calibration standards have been developed by industry consensus These standards have been calibrated by the use of precision equipment using an aperture of 6 mils (0.006 inch).

Characterization of an instrument's effective aperture, and its reflectance measurement compliance

with this *Quality Specification for the U.P.C. Printed Symbol*, are determined through the application of these standards.

3.2.1.3 Compliance Statement

Verifiers that are suitable for use with this specification will be supplied with a statement that associates the instrument with the following calibration standards:

> Applied Image certified U.P.C. Calibration Standards are manufactured to Applied Image, Inc. and Uniform Code Council, Inc. specifications, using ANSI X3.182-1990 methodology, and are calibrated using standards traceable to the National Institute of Standards and Technology.

3.2.1.4 Scanner Configuration

Verifiers shall employ an irradiation source and collection geometry that is representative of what is typically employed by U.P.C. scanners. It is recognized that a wide variety of configurations such as slot, hand held laser, CCD touch and wand scanners are used as scanning devices. Therefore, it is recommended that verifiers replicate as closely as possible the results achieved by a typical laboratory verification instrument.

The standard construction for laboratory verification instruments shall employ a source of flood incident irradiation at 45 degrees from a perpendicular to the surface and a plane containing the irradiation source that is perpendicular to the surface and parallel to the bars. The reflected light shall be collected through a circular projected aperture within a 15 degree angle centered about the perpendicular.

Verifiers approximate this geometry by various means. Compliance with each manufacturer's instructions concerning a verifier's proper orientation, use and limitations is mandatory for achieving valid results.

All measurements shall be made on a bar code symbol within the inspection band shown in Figure III-1.

3.3 Reference Reflectivity Measurements

Verification devices shall employ scanners designed to the parameters described in section 3.2.1 to develop a Scan Reflectance Profile (SRP). The SRP that is produced when a verifier is used to scan the U.P.C. printed symbol provides the vehicle for making reference reflectivity measurements.

3.4 Scan Reflectance Profile (SRP)

U.P.C. bar code symbol requirements are based on an analysis of the scan reflectance profile. Figure III-2 is a graphical representation of a Scan Reflectance Profile.

In Figure III-2, the vertical axis represents percent reflectance and the horizontal axis represents linear position. The high reflectance areas on the left and right are the quiet zones. The other high reflectance areas are spaces and the low reflectance areas are bars. The important features of the profile in Figure III-2 can be determined by manual graphical analysis or automatically by numeric analysis. For example, the highest reflectance point is approximately 79 percent and the lowest is approximately 14 percent.

The scan reflectance profile is similar to the signal from a typical bar code scanning device. In a bar code reader, this signal is processed by an edge finding circuit prior to arriving at the decoder. In order to allow a variety of edge finding circuits to find the intended elements, the following reflectance parameters should be considered: Quiet zones must be adequate and the global threshold shall be traversed by every edge in the symbol; symbol contrast, modulation, and minimum edge

contrast should not get too small; and defects and minimum reflectance should not get too big.

In addition, U.P.C. decode and decodability characteristics must be satisfactory.

3.5 Profile Reflectance Parameters

The following profile reflectance parameters shall be determined and tested for compliance with this specification. This section will describe each parameter in an appropriate sequence of determination. Figure III-3 is the same profile as Figure III-2 with certain bar code features and profile reflectance parameters indicated.

3.5.1 Edge Determination

Edge determination is based on an analysis of the SRP. Bars and spaces are identified by establishing a Global Threshold and edges are located by observation and measurement as described in the following sections.

3.5.1.1 Establish Global Threshold

The Global Threshold is the reflectance level that discriminates bars from spaces in a SRP. The global threshold is established through the middle of a profile at a constant reflectance value. The reflectance value is determined by dividing the symbol contrast (SC, see section 3.5.2.3) by 2 and adding the minimum reflectance, R_{min}.

$$GT = R_{min} + (SC/2)$$

3.5.1.2 Observe Space/Bar Reflectances (R_{space}, R_{bar})

In each region above the Global Threshold, the largest reflectance value is the space reflectance, R_{space}. In each region below the Global Threshold, the smallest reflectance value is the bar reflectance, R_{bar}.

3.5.1.3 Locate Edges

An element edge is located where the profile intersects the midpoint between R_{space} and R_{bar} of the adjoining elements. If more than one intersection exists between adjoining elements, then the profile is considered to be non-conforming. This test establishes the "Edge Determination" parameter grade. The quiet zones are considered spaces.

3.5.2 Minimum Reflectance (R_{min}) and Symbol Contrast (SC)

The SRP establishes the largest and the smallest value of reflectance across a single scan of the U.P.C. symbol. This relationship establishes Symbol Contrast.

3.5.2.1 Observe Minimum (R_{min}) and Maximum (R_{max}) Reflectance

R_{min} is the smallest reflectance value observed in a scan reflectance profile.

R_{max} is the largest reflectance value observed in a scan reflectance profile.

3.5.2.2 Determine Relationship of R_{min} to R_{max} (Establish R_{min} Parameter)

Multiply R_{max} by 0.5 and determine if this value is >, <, or = to R_{min} to identify R_{min} parameter grade.

3.5.2.3 Calculate Symbol Contrast

Symbol Contrast is the difference between the largest and smallest reflectances in a scan reflectance profile, where the profile is restricted to the symbol including its quiet zones.

$$SC = R_{max} - R_{min}$$

3.5.3 Minimum Edge Contrast (EC_{min}) and Modulation (MOD)

Minimum Edge Contrast is established by analysis of all the edges in an SRP. Modulation is defined as the ratio between the Minimum Edge Contrast and Symbol Contrast as determined in section 3.5.2.3

3.5.3.1 Observe Minimum Edge Contrast

Use paired R_{bar} and R_{space} values to analyze the SRP for the minimum difference between R_{bar} and R_{space} pairs at each element edge.

3.5.3.2 Calculate Minimum Edge Contrast

Edge contrast is the difference between the R_{space} and R_{bar} of adjoining elements including quiet zones. The smallest value of edge contrast found in the scan reflectance profile is the minimum edge contrast (EC_{min}).

$$EC = R_{space} - R_{bar}$$

3.5.3.3 Calculate Modulation

Modulation is the ratio of minimum edge contrast to symbol contrast.

$$MOD = EC_{min}/SC$$

3.5.4 Defects

Defects, irregularities found within bar or space elements and quiet zones, are determined by measuring and analyzing the relationship between the maximum element reflectance non-uniformity (ERN_{max}) and symbol contrast (SC).

3.5.4.1 Measure Maximum Individual Element Reflectance Non-Uniformity (ERN_{max})

A valley is the graphical pattern on a scan reflectance profile which looks like a "U" or "V". An inverted U or V represents a peak. Within a profile, a valley represents a bar and a peak represents a space or quiet zone. One or more peaks or valleys could also be found within an element representing a reflectance change within an element.

Element reflectance nonuniformity (ERN) within an individual element or quiet zone is the difference between the reflectance of the highest peak and the reflectance of the lowest valley. When an element consists of a single peak or valley, its reflectance nonuniformity is zero.

3.5.4.2 Calculate Defects

Defect measurement is expressed as the ratio of the maximum element reflectance nonuniformity to symbol contrast.

$$Defects = ERN_{max}/SC$$

3.5.5 Decode

This section describes the Decode algorithm to be used by verifier instruments to establish the pass or fail decode criteria. Individual verifier manufacturers may, however, wish to include more aggressive edge finding and decode algorithms for the purpose of finding and reporting the presence of a U.P.C. symbol. This technique can be extremely useful, since it will identify the presence of a U.P.C. symbol to the user, and then report the symbol's success, or failure, to meet the criteria defined in this specification.

Individual bar and space edges as discussed in section 3.5.1 are determined by use of the scan reflectance profile. Character widths (S) and edge to edge distances (t) discussed in the following sections, are converted to T values by use of the U.P.C. reference decode algorithm, and are tested for valid U.P.C. character and guard bar decodes.

3.5.5.1 U.P.C. Symbol Characteristics and Reference Decode Algorithm

The detailed structure and characteristics of various Versions of the U.P.C. symbol are discussed in Part I.

Individual character widths (S) are used to determine Reference Threshold (RT) values. Individual edge to edge values (t) are then compared to the Reference Threshold (RT) to determine T values. Character values and guard bars are determined from T values.

3.5.5.2 Measure Individual Character Widths (S) and Calculate Reference Thresholds (RT)

The character width S as shown in Figures III-4A and III-4B is the total measured width of a character. Reference Thresholds RT1, RT2, RT3, RT4 and RT5 are given by:

$$RT1=(1.5/7)S$$
$$RT2=(2.5/7)S$$
$$RT3=(3.5/7)S$$
$$RT4=(4.5/7)S$$
$$RT5=(5.5/7)S$$

3.5.5.3 Measure Individual Edge to Edge Distances (t) Values

The t value measurements extend from the leading edge of a bar to the leading edge of the adjacent bar, or the trailing edge of a bar to the trailing edge of the adjacent bar as shown in Figures III-4A and III-4B.

3.5.5.4 Determine T Values and Identify Valid Characters

Within each character, the measurements t_1 and t_2 are compared to reference thresholds RT1, RT2, RT3, RT4 and RT5 as determined in section 3.5.5.2. The corresponding integral valued measurements T1 and T2 (see Figure III-5) are considered to be equal to 2, 3, 4 or 5 as follows:

$$\text{If } RT1 < t_i < RT2,\ Ti = 2$$
$$\text{If } RT2 < t_i < RT3,\ Ti = 3$$
$$\text{If } RT3 < t_i < RT4,\ Ti = 4$$
$$\text{If } RT4 < t_i < RT5,\ Ti = 5$$

...where i=1 or 2; otherwise the character is in error.

T1 and T2 values are compared to valid values assigned to U.P.C. characters as defined in section 3.5.5.6.

3.5.5.5 Determine T Values and Identify Guard Bar Patterns

With reference to Figure III-4B, determine the appropriate S measurement to be used for determining the Reference Threshold values as shown in section 3.5.5.2. For each symbol or half symbol, the measurements of the appropriate guard bar t_x values are then compared to reference thresholds, and integral T_x measurements developed as defined by the table in section 3.5.5.4. T_x values are compared to valid guard bar values as defined in section 3.5.5.6.

3.5.5.6 Establish Decode

The scan reflectance profile must include valid quiet zones preceding the first bar and following the last bar of the symbol (see section 1.3.2). The measurement and evaluation of the Quiet Zone parameter is described in Section 3.5.7, Quiet Zone.

Between the leading and trailing quiet zone, the count of bars and spaces must be precisely correct. Version A symbols must contain 59 elements (30 bars and 29 spaces). Version E symbols must contain 33 elements (17 bars and 16 spaces). These requirements are defined in detail in Part I.

For each character, the T1 and T2 values must conform to the following table.

Character	Parity	T1	T2
0	Odd	2	3
1	Odd	3	4
2	Odd	4	3
3	Odd	2	5
4	Odd	5	4
5	Odd	4	5
6	Odd	5	2
7	Odd	3	4
8	Odd	4	3
9	Odd	3	2

Character	Parity	T1	T2
0	Even	5	3
1	Even	4	4
2	Even	3	3
3	Even	5	5
4	Even	2	4
5	Even	3	5
6	Even	2	2
7	Even	4	4
8	Even	3	3
9	Even	4	2

For each guard bar configuration, the T1, T2, T3 and T4 values must conform to the following table:

Guard Bars	T1	T2	T3	T4
Left Vers. A/E	2			
Center (left half)	2	2	2	
Center (right half)		2	2	2
Right Vers. A	2			
Right Vers. E	2	2	2	2

3.5.5.7 Identify Ambiguous Characters

Individual character values in an SRP are identified through the use of T values as described in the previous section 3.5.5.6.

All characters are uniquely identified except for the following four cases:

T1 = 3 & T2 = 4 (Odd parity 1 & 7)
T1 = 4 & T2 = 3 (Odd parity 2 & 8)
T1 = 4 & T2 = 4 (Even parity 1 & 7)
T1 = 3 & T2 = 3 (Even parity 2 & 8)

3.5.5.8 Measure Individual Character Total Bar Widths

To resolve the ambiguous character cases, combined bar width measurements ($b_1 + b_2$) as shown in Figure III-4A, are determined by using techniques described in Section 3.5.5.9.

3.5.5.9 Resolve T1, T2 Ratio Decode Ambiguities

Decode ambiguities are resolved through use of the following relationships:

For T1 = 3 and T2 = 4:
Character is a 1 if: 7 (combined width both bars)/S $\leq$ 4
Character is a 7 if: 7 (combined width both bars)/S > 4

For T1 = 4 and T2 = 3:
Character is a 2 if: 7 (combined width both bars)/S $\leq$ 4
Character is an 8 if: 7 (combined width both bars)/S > 4

For T1 = 4 and T2 = 4:
Character is a 1 if: 7 (combined width of both bars)/S > 3
Character is a 7 if: 7 (combined width both bars)/S $\leq$ 3

For T1 = 3 and T2 = 3:
Character is a 2 if: 7 (combined width both bars)/S > 3
Character is an 8 if: 7 (combined width both bars)/S $\leq$ 3

3.5.5.10 Validate Parity and Modulo Check Digit

The final parts of the Decode validation process are:

- The parity specifications for the various versions of the U.P.C. symbol as defined for the Version A symbol in section 1.3.2.1 and for version E in section 1.3.2.2.

- The check digit requirements as specified for Version A in section 1.3.2.1 and for Version E in section 1.3.2.2.

3.5.6 Decodability

Decodability of a U.P.C. symbol is a measure of its printing accuracy in relation to the reference decode algorithm.

Individual character and guard bar decodability is determined by measuring individual guard bar or character t distances, or (b_1+b_2) bar code sums, and calculating their percent deviation from the achieved average value toward their reference thresholds as follow.

3.5.6.1 Character Decodability of 0, 3, 4, 5, 6 and 9

A decodability value V is calculated for each character. For i = 1 and 2 and j = 2, 3, 4:

$$K = \text{smallest } \{|ti - RTj|\}$$

$$V = K/(S/14)$$

3.5.6.2 Character Decodability for 1, 2, 7, and 8

A decodability value V is calculated for each character. For i = 1 and 2 and j = 2, 3, 4:

$$K = \text{smallest } \{|ti - RTj|\}$$

$$V_1 = K/(S/14)$$

For odd parity characters 1, 2, 7, or 8 the value V_2 is given by:

$$V_2 = \frac{|(7/S)(\text{combined width of both bars}) - 4|}{(15/13)}$$

For even parity characters 1, 2, 7, or 8 the value V2 is given by:

$$V_2 = \frac{|(7/S)(\text{Combined width of both bars}) - 3|}{(15/13)}$$

For each character 1, 2, 7, or 8 the decodability value V equals the smaller of V_1 or V_2.

3.5.6.3 Guard Bar Decodability

A decodability value V is calculated for each guard bar configuration, as appropriate for the U.P.C. symbol undergoing evaluation. Procedures are the same as employed for determining non-ambiguous character decodability values.

3.5.6.4 Establish Scan Decodability

The scan profile decodability value is the smallest value of V for any character or guard bar measured in an SRP as described in section 3.5.6.1 and in section 3.5.6.2.

3.5.7 Quiet Zone

A minimum width of uniform light contrast adjacent to the outer edges of the left and right hand symbol guard bars, is required to facilitate finding and decoding the U.P.C. symbol.

For Version A symbols and the left side of Version E symbols, the quiet zone should equal or exceed 9 modules. The measured value determined by a verifier instrument should never be less than 8 modules. For the right side of the Version E symbol the quiet zone should equal or exceed 7 modules. The measured value determined by a verifier instrument should never be less than 6.2 modules.

3.6 Symbol Environment

3.6.1 Substrate

Factors discussed in Appendix E such as opacity, showthrough, and wrapper transparency shall be a required part of the U.P.C. symbol configuration when the symbol is being tested for compliance with this *Quality Specification for the U.P.C. Printed Symbol.*

3.6.2 Scan Reflectance Profile (SRP) Grading

Scan reflectance profile grading is a method of identifying relative levels of print quality. The grading scheme follows academic letter or equivalent number grades of A (4), B (3), C (2), D (1), and F (0) where A is the best grade, D is the worst grade and F designates failure.

Reflectance variations may be caused by spots, voids, smudges and other defects which may interfere with decoding, since scanners respond to reflectivity differences. Reflectance requirements are not independent and shall be considered simultaneously.

3.6.3 Profile Reflectance Parameter Grading

The following sections identify grade specifications for a single scan across the U.P.C. symbol (See Figure III-3). Profile reflectance parameters resulting from U.P.C. symbol measurements are made in compliance with section 3.5.

3.6.3.1 Edge Determination

See section 3.5.1

Grade	Edge Determination
A (4)	Conforming: Version A — 59 elements (30 bars, 29 spaces) Version E — 33 elements (17 bars, 16 spaces)
F (0)	Non-conforming

3.6.3.2 Minimum Reflectance (R_{min})

See section 3.5.2.1

Grade	R_{min}
A (4)	$\leq 0.5 \times R_{max}$
F (0)	$> 0.5 \times R_{max}$

3.6.3.3 Symbol Contrast (SC)

See section 3.5.2.3

Grade	(SC)
A (4)	≥ 70%
B (3)	≥ 55%
C (2)	≥ 40%
D (1)	≥ 20%
F (0)	< 20%

3.6.3.4 Minimum Edge Contrast (EC_{min})

See sections 3.5.3.1 and 3.5.3.2

Grade	(EC_{min})
A (4)	≥ 15%
F (0)	< 15%

3.6.3.5 Modulation (MOD)

See section 3.5.3.3

Grade	(MOD)
A (4)	≥ 70%
B (3)	≥ 60%
C (2)	≥ 50%
D (1)	≥ 40%
F (0)	< 40%

3.6.3.6 Defects

See section 3.5.4

Grade	Defects
A (4)	≤ 15%
B (3)	≤ 20%
C (2)	≤ 25%
D (1)	≤ 30%
F (0)	> 30%

3.6.3.7 Decode

See section 3.5.5

Grade	Decode
A (4)	Valid character and symbol decode
F (0)	Invalid character and symbol decode

3.6.3.8 Decodability

See section 3.5.6

Grade	Decodability
A (4)	≥ 62%
B (3)	≥ 50%
C (2)	≥ 37%
D (1)	≥ 25%
F (0)	< 25%

3.6.3.9 Quiet Zone

See section 3.5.7

Grade	Quiet Zone
A (4)	Meets minimum requirement for quiet zone widths
F (0)	Fails minimum requirement for quiet zone widths

3.6.4 Develop Overall Scan Reflectance Profile (SRP) Grade

The overall SRP grade is the <u>lowest</u> grade received by the following parameters:

- Edge Determination
- Minimum Reflectance
- Symbol Contrast
- Minimum Edge Contrast
- Modulation
- Defects
- Decode
- Decodability
- Quiet Zone

3.6.5 Symbol Grading

Multiple SRPs are graded and averaged to determine a U.P.C. symbol grade.

3.6.5.1 Scan Criteria

The formal verification of a U.P.C. symbol requires ten scan reflectance profiles spaced with reasonable uniformity along the symbol as shown in Figure III-1. Diagonal scans are also acceptable. For symbols with short bar height, the scans may overlap.

An informal estimate of symbol quality may be based on a smaller number of scan reflectance profiles.

3.6.5.2 Decode Data Comparison Test

If any two scans yield different decoded data, the symbol receives a failing grade of F (0).

3.6.5.3 Multiple SRP Grade Averaging

The calculated symbol grade is the simple average of all the overall profile grades (see section 3.6.2) using the standard weighting of 4.0 = A, 3.0 = B, 2.0 = C, 1.0 = D, and 0.0 = F. The symbol grade is stated as a decimal, such as 2.7.

A more complete statement of this symbol grade may be expressed as 2.7/06/670, where 06 identifies aperture size and 670 identifies the nominal wavelength of the verifier.

Symbol grades of 1.5 or higher are passing. Lower grades are failing.

Note: The minimally acceptable grade of 1.5 applies to the final symbol on the package at the point of sale. It is clearly appropriate to strive for a higher symbol grade at the point of printing to allow for process variations and possible degradation from packaging, storage, shipping and handling. ***Wherever practical, it is recommended that the symbol grade as printed should equal or exceed 2.5.***

FIGURE III-1
Inspection Band

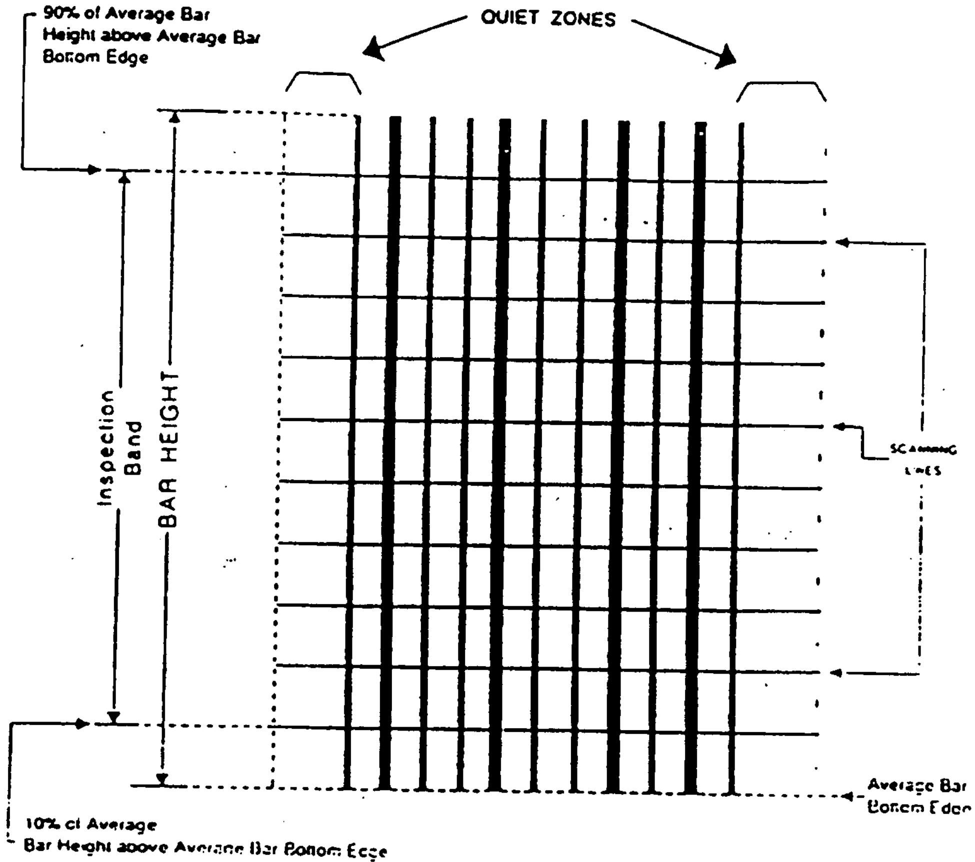


FIGURE III-2
Scan Reflectance Profile

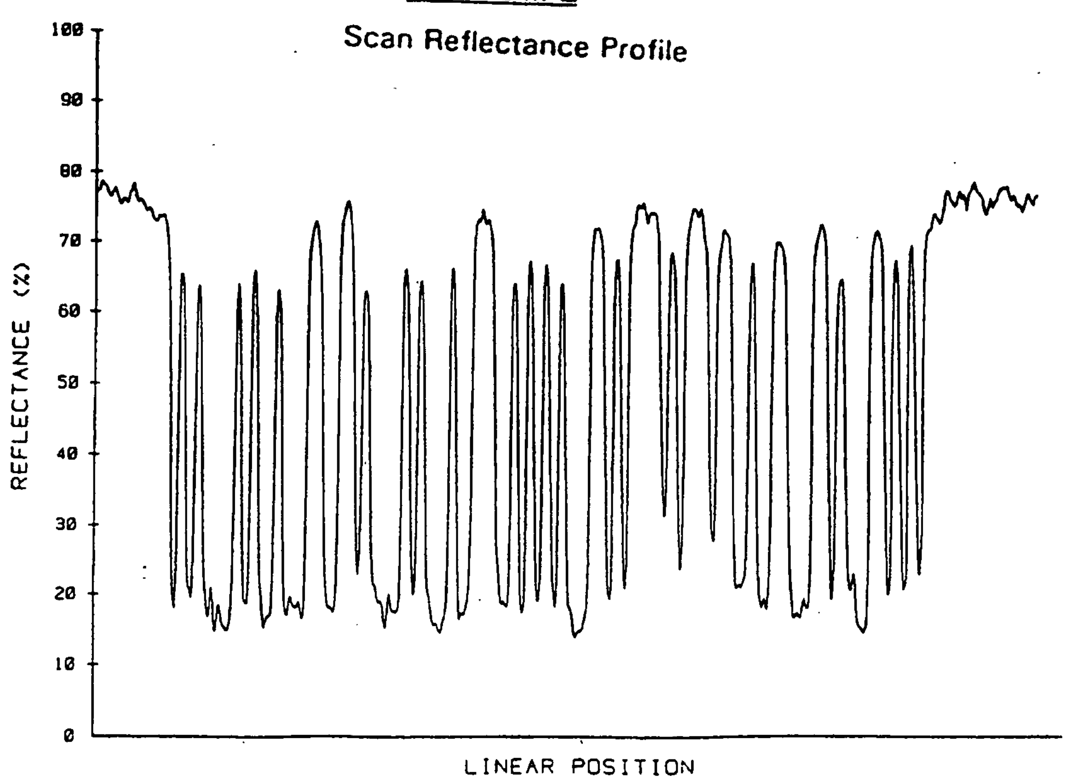


FIGURE III-3

Scan Reflectance Profile from Figure 2
with Features Detailed

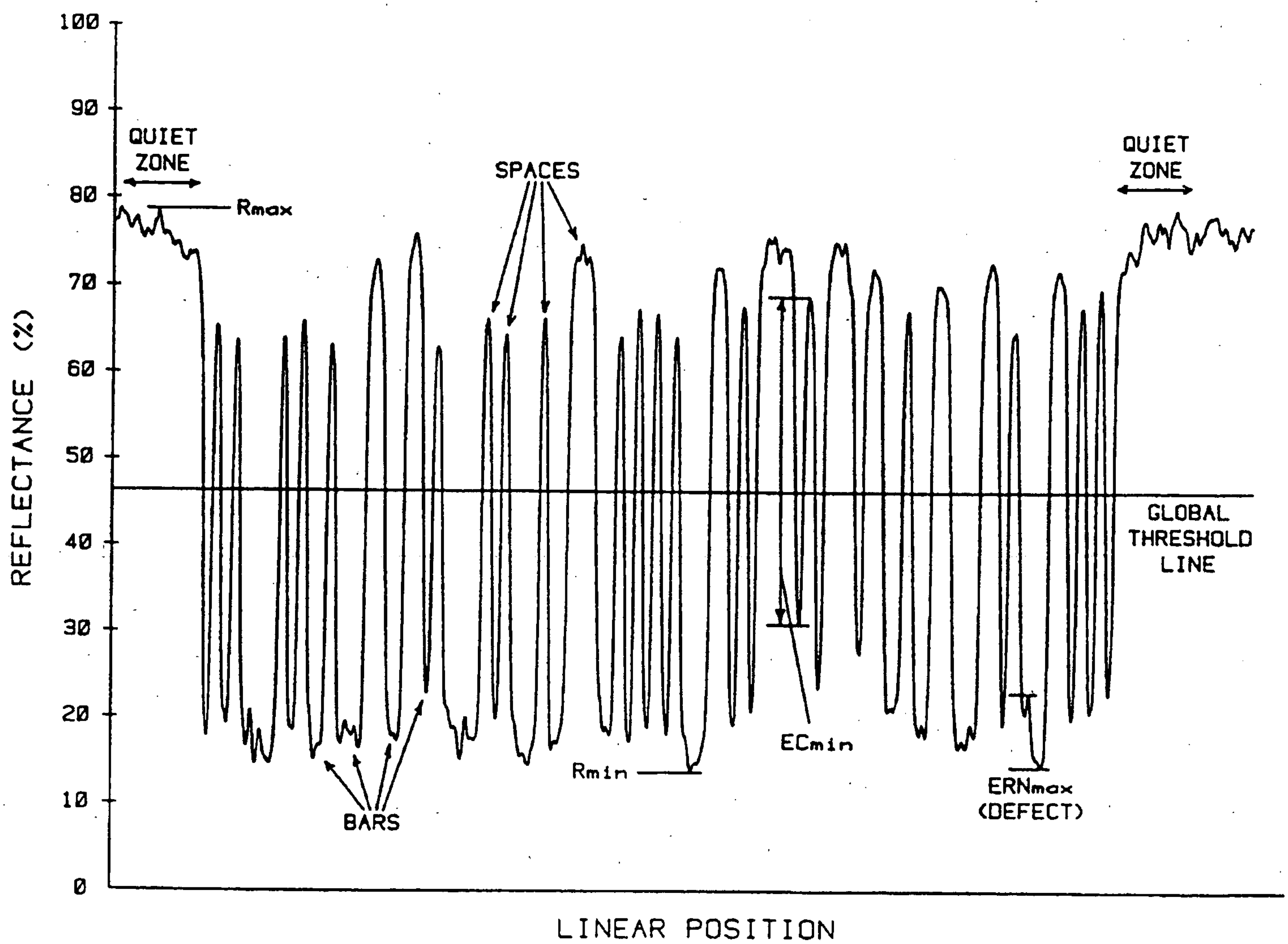
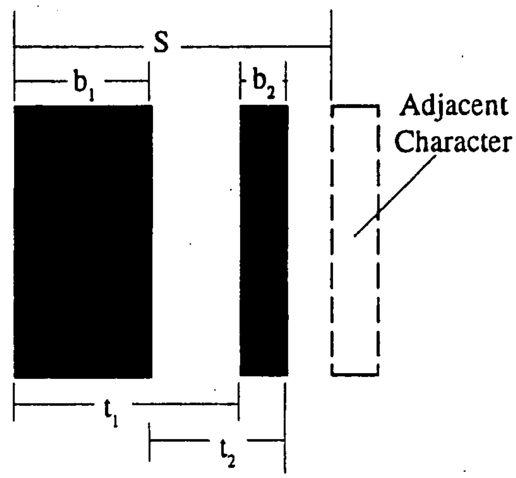


Figure III-4A: Character Structure

Right side of Version A



Left side of Version A or Version E

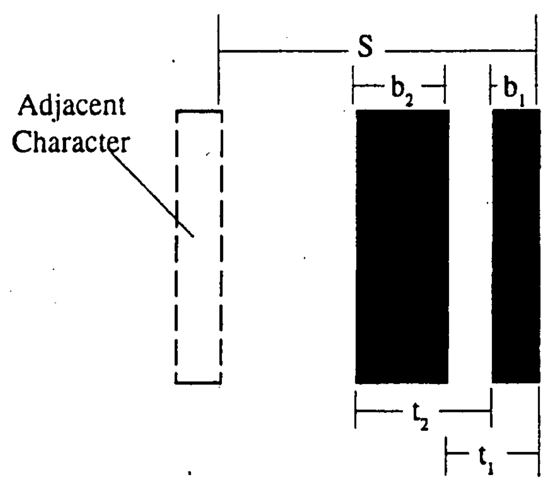


Figure III-4B: Guard Bar Structures

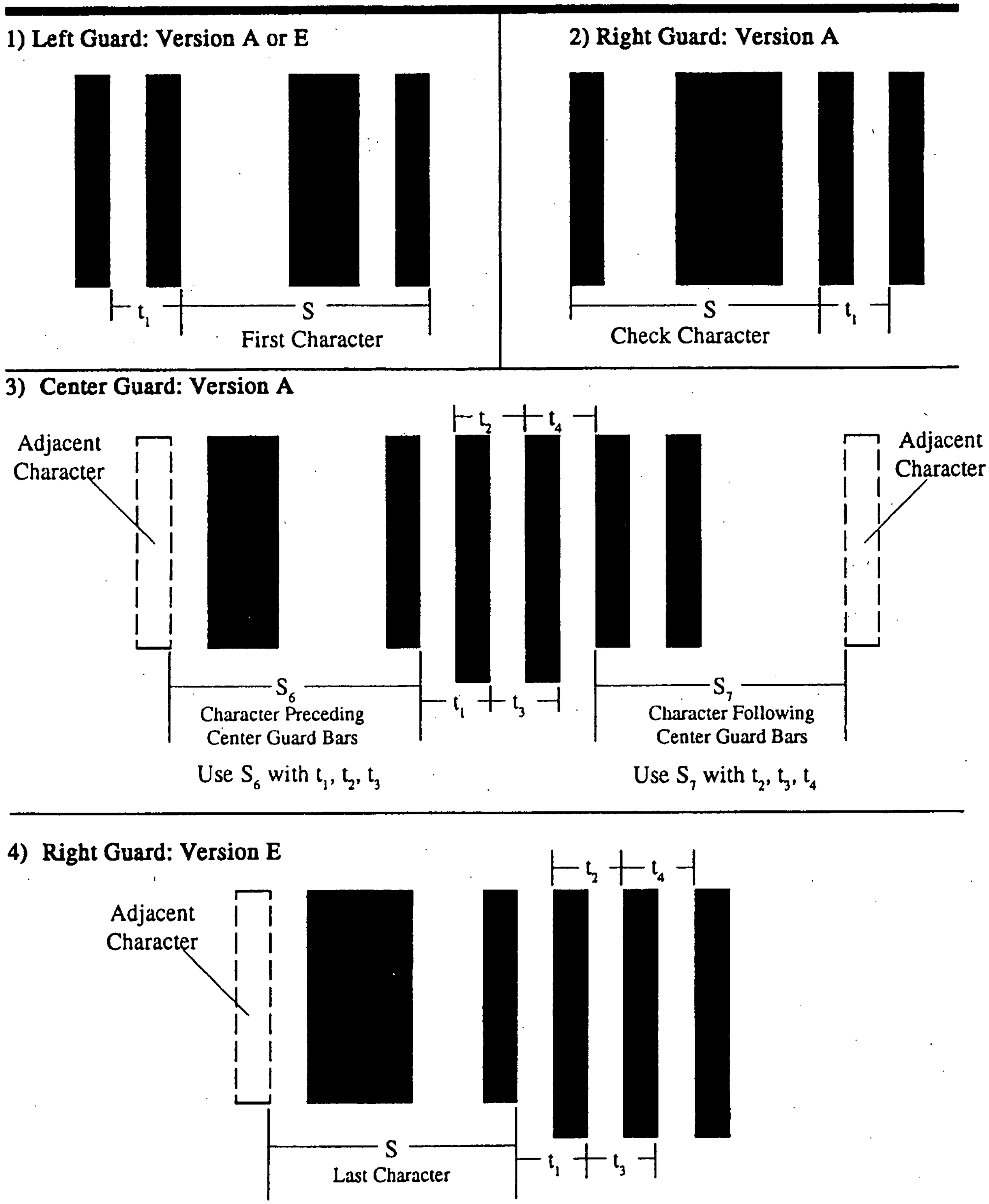


Figure III-5

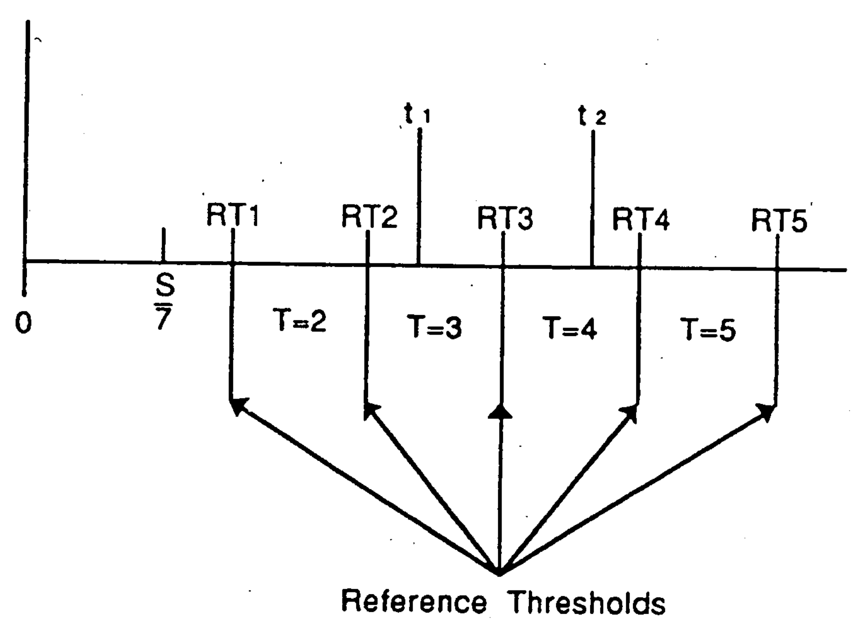
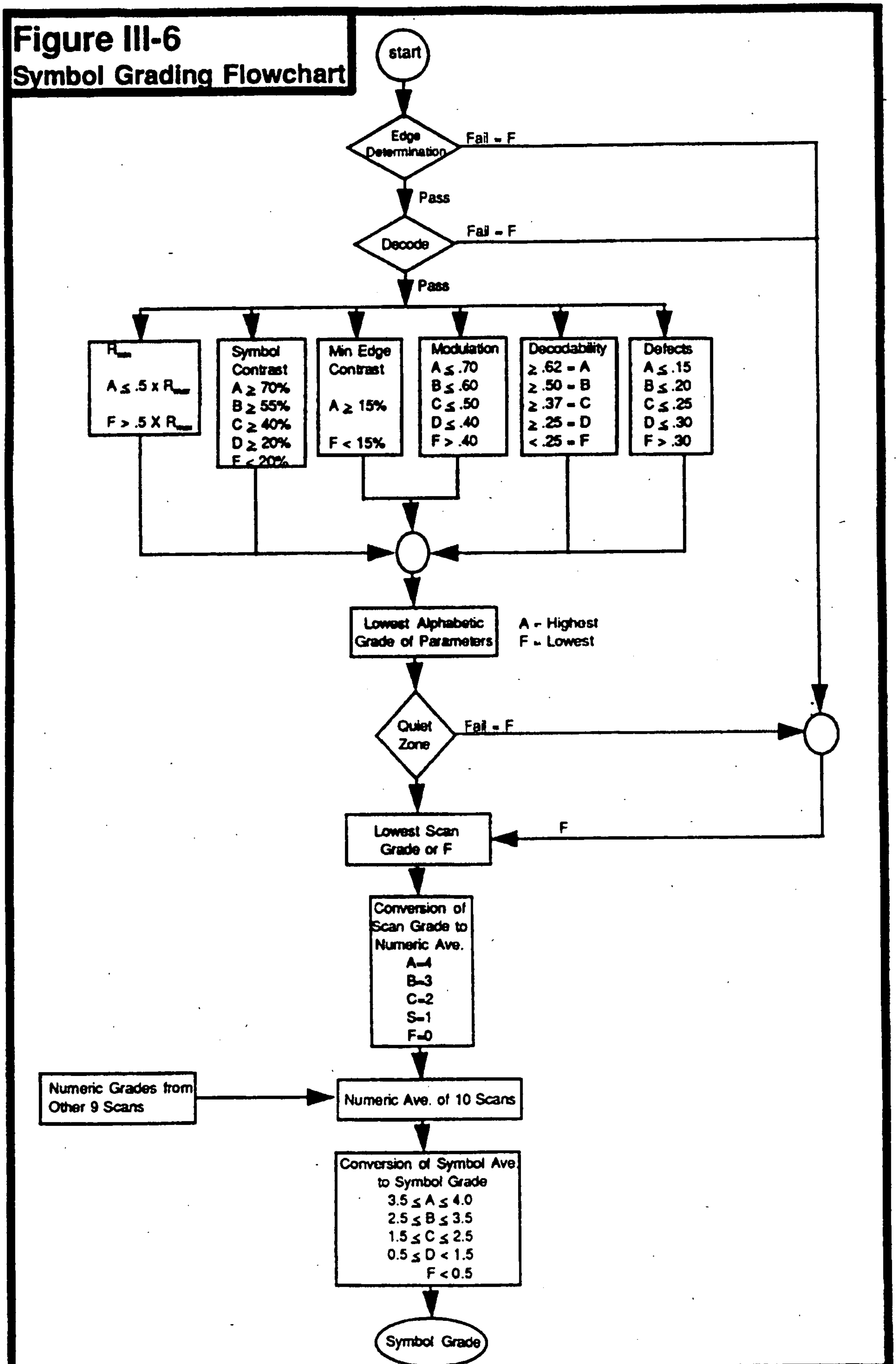


Figure III-6
Symbol Grading Flowchart



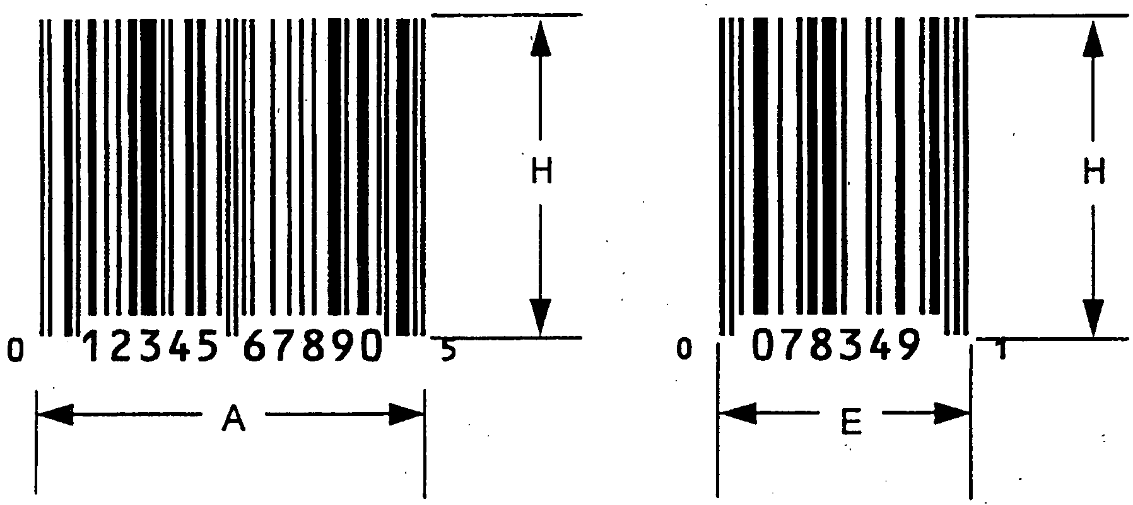
Appendices

Appendix A Truncation

The U.P.C. symbol geometry facilitates ominidirectional scanning. Any truncation (shortening of the bar height) degrades this scanning ability. The more the bars are shortened, the more precisely the symbol must be presented to the scanner. Truncated symbols require re-scanning more often than do full height symbols.

It is recognized that the size or shape of some packages make it impossible to accommodate a full height U.P.C. symbol. In such cases, the bars should be printed as tall as possible. No truncation is permitted by this *Quality Specification for the U.P.C. Printed Symbol* packages large enough to accommodate a full height symbol.

The following technique may be used to quickly estimate whether a printed U.P.C. symbol has been truncated, where dimensions A, E, and H are defined in the figures below:



For the version A symbol, the bar height H must equal or exceed 25/32 times dimension A. For the version E symbol, H must exceed 1-7/16 times dimension E. The table on the following page expresses these relationships in inches for selected magnifications:

Dimension A	Dimension E	Minimum H	Magnification
0.99	0.53	0.77	0.80
1.05	0.56	0.82	0.85
1.11	0.60	0.86	0.90
1.17	0.63	0.91	0.95
1.23	0.66	0.96	1.00
1.30	0.70	1.01	1.05
1.36	0.73	1.06	1.10
1.48	0.80	1.15	1.20
1.61	0.86	1.25	1.30
1.73	0.93	1.34	1.40
1.85	0.99	1.44	1.50
2.16	1.16	1.68	1.75
2.47	1.33	1.92	2.00

d

Appendix B: Metric U.P.C. Symbol Specifications

The nominal metric module is 0.330 mm wide. Using the widths (A) shown in Part I, Drawings 1-7, the metric equivalents (B) are given below:

A Inches	B Millimeters
.0120	.305
.0130	.330
.0250	.635
.0260	.660
.0270	.685
.0390	.990
.0400	1.015
.0510	1.295
.0520	1.320
.0640	1.625
.0650	1.650
.0660	1.675
.0780	1.980
.0790	2.005
.0910	2.310
.1170	2.970
.1430	3.630
.1820	4.620
.2340	5.944
.9390	23.851

Note: .305 mm = .012007... inches
.330 mm = .012992...inches

Note: These metric dimensions are multiples of .330 with the exception that .025 mm has been removed or added to those corresponding to the digits 1, 2, 7 and 8 according to the same rules as used in Part I, Drawing I-6 and I-7.

A tolerance of $\pm$0.005 mm is the equivalent of $\pm$0.0002 inches (0.005 mm = 0.000196...inches) and $\pm$0.013 mm is the equivalent of $\pm$0.0005 inches (0.013 mm = 0.000511...inches).

The height (H_m) associated with a nominal metric symbol equivalent to a height (H) of a nominal U.P.C. symbol is defined as follows:

H Inches	H_m Millimeters
1.020	25.91
.965	24.51
.912	23.16
.900	22.86
.462	11.73

A tolerance of ± 0.12 mm is the metric equivalent of $\pm$ 0.005 inches.

f

Appendix C: Nominal Dimensions (English)

	Dimensions in inches				Dimension in mils where 1 mil=0.001 inch					
Magnification	Left Edge of First Bar to Right Edge of Last Bar		Total Width Including Margins		Char. Width (7 modules)	Char. Width/7 (1 module)	Nominal Margin: Left (from left edge of 1st bar)	Nominal Margin: Right (from right edge of last bar)		Min. Guard Bar Height
	Version A	Version E	Version A	Version E	Vers. A/E	Vers. A/E	Vers. A/E	Version A	Version E	Vers. A/E
* .80	.988	.530	1.175	.697	72.8	10.4	93.6	93.6	72.8	768
.85	1.045	.561	1.243	.737	77.0	11	99.5	99.5	77.4	812
* .90	1.112	.597	1.322	.784	81.9	11.7	105.3	105.3	81.9	864
.92	1.150	.612	1.356	.804	84.0	12	107.6	107.6	83.7	886
** 1.00	1.235	.663	1.469	.871	91.0	13	117.0	117.0	91.0	960
1.08	1.330	874	1.682	.938	.98	14	126.4	126.4	98.3	1034
* 1.1	1.659	.429	1.616	.958	100.1	14.3	128.7	128.7	100.1	1056
1.15	1.425	.765	1.695	1.005	105.0	15	134.6	134.6	104.8	1108
* 1.2	1.482	.796	1.763	1.045	109.2	15.6	140.4	140.4	109.2	1152
1.23	1.520	.816	1.808	1.072	112.0	16	143.9	143.9	11.9	1182
* 1.3	1.606	.862	1.910	1.132	118.3	16.7	152.1	152.1	118.3	1248
1.31	1.615	.867	1.921	1.139	119.0	17	153.3	153.3	119.2	1255
* 1.38	1.710	.918	2.034	1.206	126.0	18	161.5	161.5	125.6	1329
1.4	1.829	.928	2.057	1.219	127.4	18.2	163.8	163.8	127.4	1344
* 1.46	1.805	.969	2.147	1.273	133.0	19	170.8	170.8	132.9	1403
1.5	1.853	.995	2.204	1.307	136.5	19.5	175.5	175.5	136.5	1440
* 1.54	1.900	1.020	2.260	1.340	143.3	20	180.2	180.2	140.1	1477
1.6	1.976	1.061	2.350	1.394	145.6	20.8	187.2	187.2	145.6	1536
* 1.62	2.000	1.071	2.373	1.407	147.0	21	189.5	189.5	147.4	1551
1.69	20.90	1.122	2.486	1.474	154.0	22	197.7	197.7	153.8	1625
* 1.7	2.100	1.127	2.497	1.481	154.7	22.1	198.9	198.8	154.7	1632
1.77	2.185	1.173	2.599	1.541	161.0	23	207.1	207.1	161.1	1698
* 1.8	2.223	1.193	2.644	1.568	163.8	23.4	210.6	210.6	163.8	1728
1.85	2.280	1.224	2.712	1.608	168.0	24	216.5	216.5	168.4	1772
* 1.90	2.347	1.260	2.791	1.655	172.9	24.7	222.3	222.3	172.9	1824
1.92	2.375	1.275	2.825	1.675	175.0	25	224.6	224.6	174.7	1846
* 2.00	2.470	1.326	2.938	1.742	182.0	26	234.0	234.0	182.0	1920

* Exact number
** At magnification = 1 (metric) module = 0.33 mm

Appendix C: Nominal Dimensions (Metric)

All Dimensions in millimeters

Magnification	Left Edge of First Bar to Right Edge of Last Bar		Total Width Including Margins		Char. Width (7 modules)	Char. Width/7 (1 module)	Nominal Margin: Left (from left edge of 1st bar)	Nominal Margin: Right (from right edge of last bar)		Min. Guard Bar Height
	Version A	E	Version A	E	Vers. A/E	Vers. A/E	Vers. A/E	Version A	E	Vers. A/E
* .80	25.08	13.46	29.83	17.69	1.848	.264	2.38	2.38	1.85	19.50
.82	25.65	13.77	30.51	18.09	1.890	.270	2.44	2.44	1.89	19.94
* .90	28.21	15.15	33.56	19.90	2.079	.297	2.67	2.67	2.08	21.93
.91	28.50	15.30	33.90	20.10	2.100	.300	2.70	2.70	2.10	22.15
** 1.0	31.35	16.83	37.29	22.11	2.310	.330	2.97	2.97	2.31	24.37
1.09	34.20	18.36	40.68	24.12	2.520	.360	3.24	3.24	2.52	26.58
* 1.1	34.48	18.51	41.02	24.32	2.541	.363	3.27	3.27	2.54	26.81
1.18	37.05	19.89	44.07	24.13	2.730	.390	3.50	3.50	2.73	28.80
* 1.2	37.62	20.20	44.72	26.53	2.772	.396	3.56	3.56	2.77	29.24
1.24	38.95	20.91	46.33	27.47	2.870	.410	3.68	3.68	2.86	30.28
* 1.3	40.75	21.88	48.48	28.74	3.003	.429	3.86	3.86	3.00	31.68
1.33	41.80	22.44	49.72	29.48	3.080	.440	3.95	3.95	3.07	32.49
* 1.4	43.89	23.56	52.21	30.95	3.234	.462	4.16	4.16	3.23	34.12
1.42	44.65	23.97	53.11	31.49	3.290	.470	4.22	4.22	3.28	34.71
* 1.5	47.02	25.25	55.93	33.17	3.465	.495	4.46	4.46	3.47	36.55
1.52	47.50	25.50	56.50	33.50	3.500	.500	4.51	4.51	3.51	36.92
* 1.6	50.16	26.93	59.66	35.38	3.696	.528	4.75	4.75	3.70	38.99
1.61	50.35	27.03	59.89	35.51	3.710	.530	4.78	7.78	3.71	39.14
* 1.7	53.29	28.61	63.39	37.59	3.927	.561	5.05	5.05	3.93	41.35
1.79	56.05	30.09	66.67	39.53	4.130	.590	5.32	5.32	4.14	43.57
* 1.8	56.43	30.29	67.12	39.80	4.158	.594	5.35	5.35	4.16	43.86
1.88	58.90	31.62	70.06	41.54	4.340	.620	5.58	5.58	4.34	45.78
* 1.9	59.56	31.98	70.85	42.01	4.389	.627	5.64	5.64	4.39	46.30
1.97	61.75	33.15	73.45	43.55	4.550	.650	5.85	5.85	4.55	48.00
* 2.0	62.70	33.66	74.58	44.22	4.620	.660	5.94	5.94	4.62	48.74

* Exact number
** At magnification = 1 (metric) module = 0.33 mm

h

Appendix D Supplemental Encodations (Two Character and Five-Character) to U.P.C. Symbol

These supplemental encodations were designed for use on periodicals and paperback books. Used in conjunction with the U.P.C. symbol, they satisfy the following requirements:

1. The first bar of the supplemental encodation symbol is separated by nine modules from the last bar of the U.P.C. symbol for both Version A and Version E symbols.

2. The supplemental encodations are unlikely to be confused with the U.P.C. symbol for any existing scanner designs.

3. The decode algorithm of the supplemental encodations is similar to the U.P.C.

4. The 2-character supplemental code was designed for periodical issue number and should be used only in that specific application.

This section presents details of two supplemental encodations: a 2-character supplemental encodation and a 5-character supplemental encodation.

Although compatible with the U.P.C. symbol, the supplemental encodations cannot be mistaken for a U.P.C. symbol or part of the U.P.C. symbol by scanners designed to read only standard U.P.C. symbols because there is only one guard pattern and each character is separated by a delineator character that is encoded 01 (each digit representing a module, "0" representing a light module and "1" representing a dark module). The left-hand guard pattern is unique — encoded 1011, differentiating it from the U.P.C. symbol's left-hand and right-hand guard bar patterns encoded 101. A right-hand guard pattern for the supplemental encodations is not required.

General Description of Supplemental Encodations

Characters are to be encoded using the 20 patterns defined for use in Version E of the U.P.C. symbol. The left-hand guard pattern of the supplemental encodation contains four nominal 0.013-inch modules for the nominal-size supplemental encodation and is encoded 1011 (i.e., bar-space-bar-bar). There is no center pattern and no right-hand guard pattern. Each character is separated by a delineator. The delineator contains two nominal 0.0130-inch modules for the nominal-size supplemental encodation and is encoded 01 (i.e., space-bar).

Add-on Number	Parity Pattern	Add-on Number	Parity Pattern	Add-on Number	Parity Pattern	Add-on Number	Parity Pattern
00	OO	25	OE	50	EO	75	EE
01	OE	26	EO	51	EE	76	OO
02	EO	27	EE	52	OO	77	OE
03	EE	28	OO	53	OE	78	EO
04	OO	29	OE	54	EO	79	EE
05	OE	30	EO	55	EE	80	OO
06	EO	31	EE	56	OO	81	OE
07	EE	32	OO	57	OE	82	EO
08	OO	33	OE	58	EO	83	EE
09	OE	34	EO	59	EE	84	OO
10	EO	35	EE	60	OO	85	OE
11	EE	36	OO	61	OE	86	EO
12	OO	37	OE	62	EO	87	EE
13	OE	38	EO	63	EE	88	OO
14	EO	39	EE	64	OO	89	OE
15	EE	40	OO	65	OE	90	EO
16	OO	41	OE	66	EO	91	EE
17	OE	42	EO	67	EE	92	
18	EO	43	EE	68	OO	93	OE
19	EE	44	OO	69	OE	94	EO
20	OO	45	OE	70	EO	95	EE
21	OE	46	EO	71	EE	96	OO
22	EO	47	EE	72	OO	97	OE
23	EE	48	OO	73	OE	98	EO
24	OO	49	OE	74	EO	99	EE

Five-character supplemental encodation (Drawing 2)

To determine the value of the parity pattern for the 5-character supplemental encodation, a value "X" is calculated in a manner similar to that used in calculating the modulo check character for the U.P.C.

For example, assume the supplemental numbers to be encoded are 98531:

Step 1: Starting at the left, sum the first, third and fifth numbers of the add-on.
(For the example — 9+5+1=15)

Step 2: Multiply the sum obtained in Set 1 by "3."
(The product for the example is 45)

Step 3: Sum the second and fourth positions and multiply the sum by "9."
(For the example — 9(8+3)=99)

Step 4: The value for "X" is the units position of the sum of Steps 2 and 3.
(For the example — 45+99=144 and therefore X=4)

The parity pattern can now be determined by using the following table:

X	Parity Pattern
0	EEOOO
1	EOEOO
2	EOOEO
3	EOOOE
4	OEEOO
5	OOEEO
6	OOOEE
7	OEOEO
8	OEOOE
9	OOEOE

For the example, since X=4 the parity pattern is OEEOO.

DRAWING 1

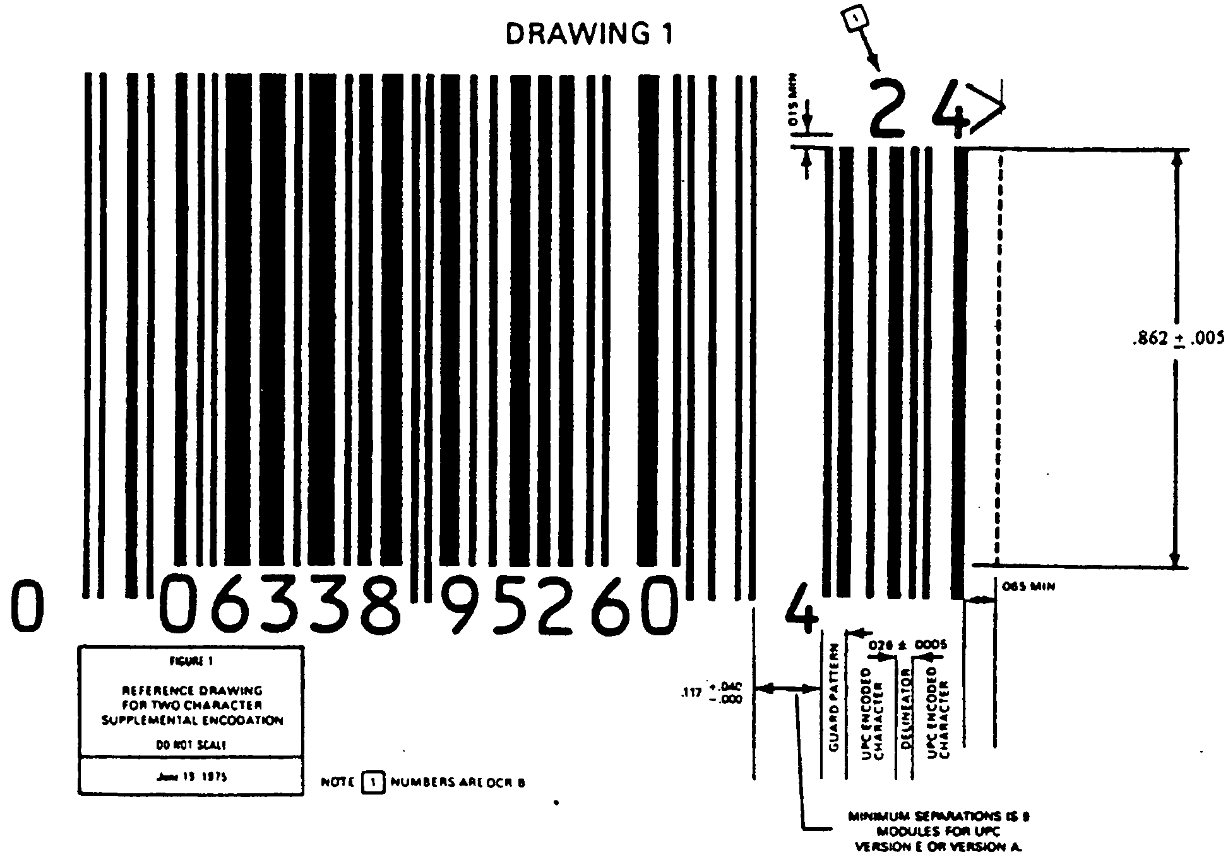


FIGURE 1

REFERENCE DRAWING FOR TWO CHARACTER SUPPLEMENTAL ENCODATION

DO NOT SCALE

June 19 1975

NOTE [1] NUMBERS ARE OCR B

NOTE: ALL DIMENSIONS ARE IN INCHES AND BASED ON 100% NOMINAL SIZE.

DRAWING 2

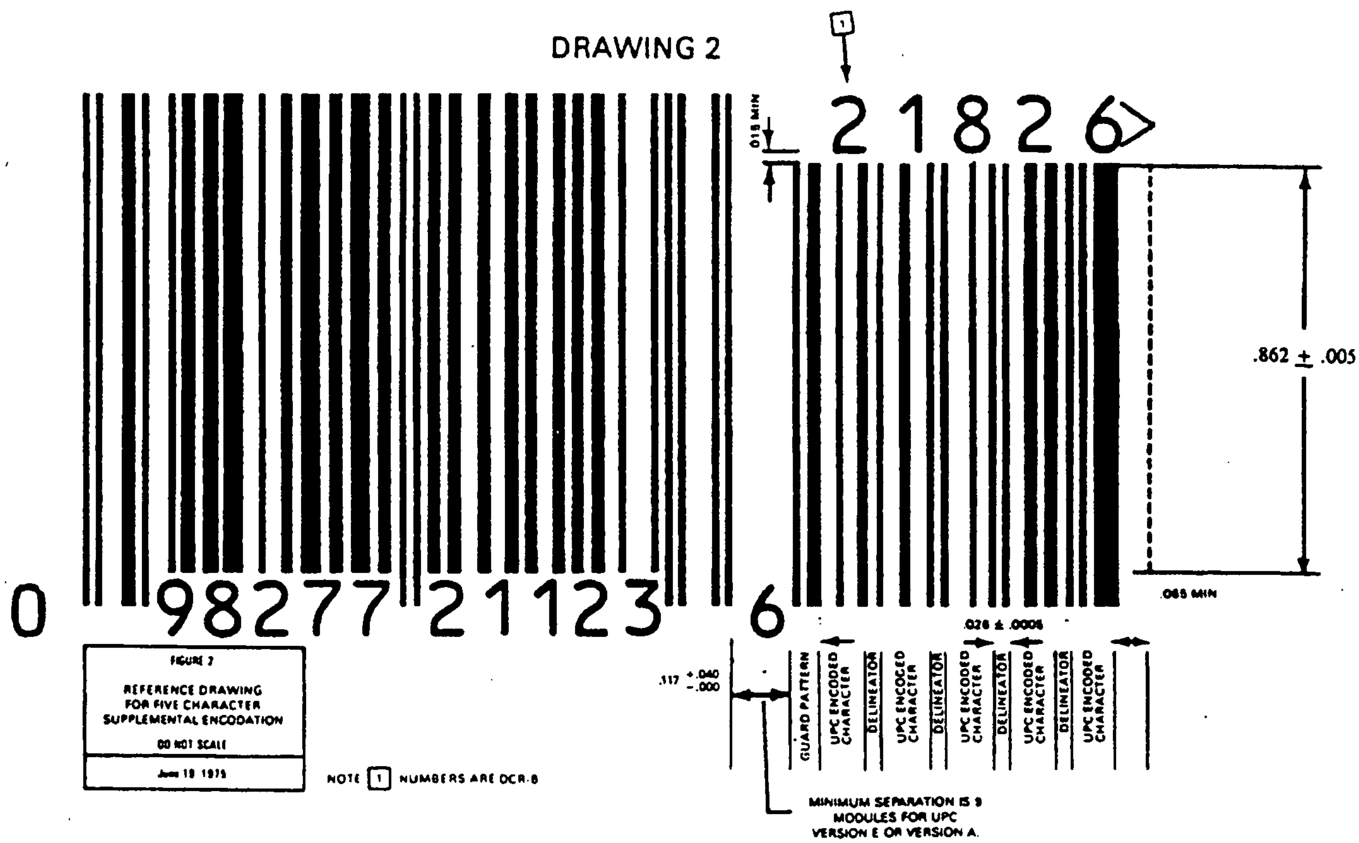


FIGURE 2

REFERENCE DRAWING FOR FIVE CHARACTER SUPPLEMENTAL ENCODATION

DO NOT SCALE

June 19 1975

NOTE [1] NUMBERS ARE OCR-B

NOTE: ALL DIMENSIONS IN INCHES AND BASED ON 100% NOMINAL SIZE.

Appendix E General Optical Requirements

E.1 Gloss

There are no current restrictions if the verification process of Part III is met. Note, however, section E.5 concerning specularly reflecting materials.

E.2 Opacity and Showthrough

In some packages the product or some under "material" may show through the light areas to a sufficient extent that the light area will appear as dark to the scanner. Accordingly, in situations with this potential problem, the finished product — not just the outer package — should be subjected to the procedures for verification (Part III).

It has been observed that various materials reflect light differently, as a function of bar and space dimensions. This has been especially evident on transparent and translucent packages where the background (space) is not printed.

The *Quality Specification for the U.P.C. Printed Symbol* should be met when the product is in the form in which it will be sold.

E.3 Color

Any combination of colors that will meet the symbol contrast (Part III) can be used to represent the "dark" bars and "light" background.

As a general guide to color selection, it is the cyan content of a color that yields the dark tone when viewed through the Wratten 26 filter; magenta and yellow correspond to light tone. Inks used in the background area must be of sufficiently low gloss to enable the symbol contrast specified in Part III to be met.

Half tone screening of the symbol background should be avoided wherever possible. If the background must contain half-tone dots, then the entire background must meet the requirements in this specification.

E.4 Transparent Wrapper

A transparent wrapper over the printed symbol tends to reduce contrast slightly. If a transparent wrapper is used over the printed symbol, the transparent wrapper shall be considered an integral part of the symbol and all reflectance measurements shall be made with the wrapper on the surface.

E.5 Specularly Reflecting Materials

The use of specularly reflecting materials to directly provide either light or dark areas of the symbol should be avoided. If such material is the substrate for a symbol, the symbol should be provided by overprinting the substrate with two inks with sufficiently different light-absorbing characteristics to meet the requirements of Part III.

If the use of specularly reflecting materials is unavoidable, as with the two-piece can, and the symbol surface is rigid, the spaces should be printed in a light color to nominal specifications and the bars should be provided by the specularly reflecting substrate, preferably by leaving bare substrate or by printing any portion of the bar area with a transparent ink that does not significantly change reflectance.

If the bar area is not printed, it is preferable that the entire symbol surface be varnished.

Printing of the symbol in sizes below a 1.00 magnification is not recommended.

It is preferable that the human-readable number be highly visible.

These packages frequently verify below the acceptable 1.5 grade level although they scan well on slot scanners. Some types of hand-held scanners may have difficulty with such symbols.

E.6 Obscuring Patterns

Under certain circumstances it may be desirable to obscure a symbol(s) — e.g., on the individual unit packs in a multipack container that carries its own symbol. To accomplish this, a solid layer of ink is sometimes applied over the symbol(s) that are to be obscured. This is not, however, always effective. Therefore, the following procedure is suggested for introducing spurious "noise" into the scanner logic and ensuring a non-read of the symbol(s).

When the obscuring pattern (see examples that follow) is in place over the symbol to be obscured, the obscuring pattern itself must be such that it will result in failure to read the U.P.C. as determined in Part III, section 3.5.5. The bar width of the obscuring pattern should be the "target" module width for the magnification factor of the symbol being obscured. The space width of the obscuring pattern should be no more than twice its own bar width.

OBSCURING PATTERNS

FIGURE 5C — PATTERNS WHICH DO OBSCURE THE SYMBOL

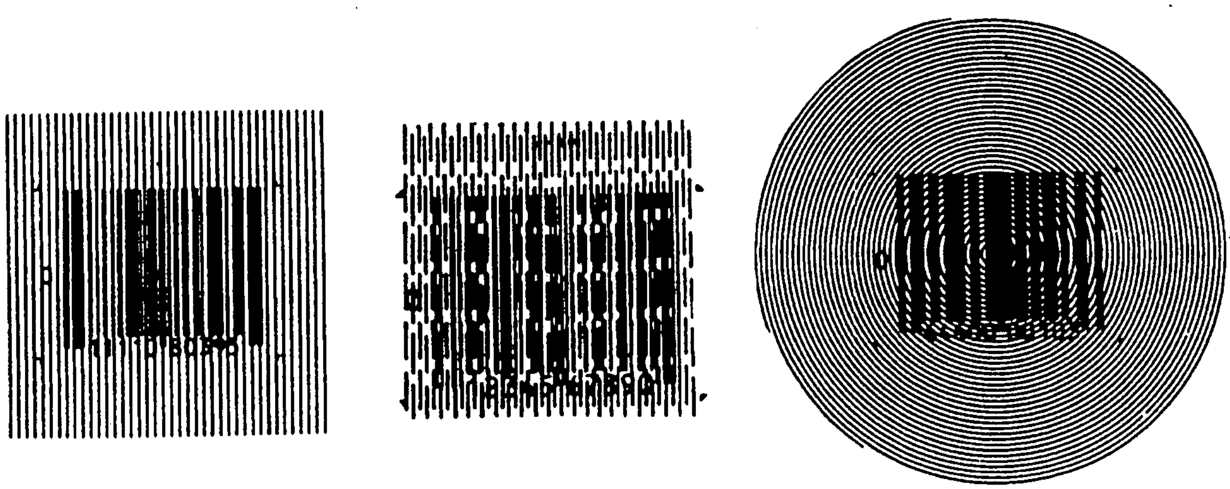
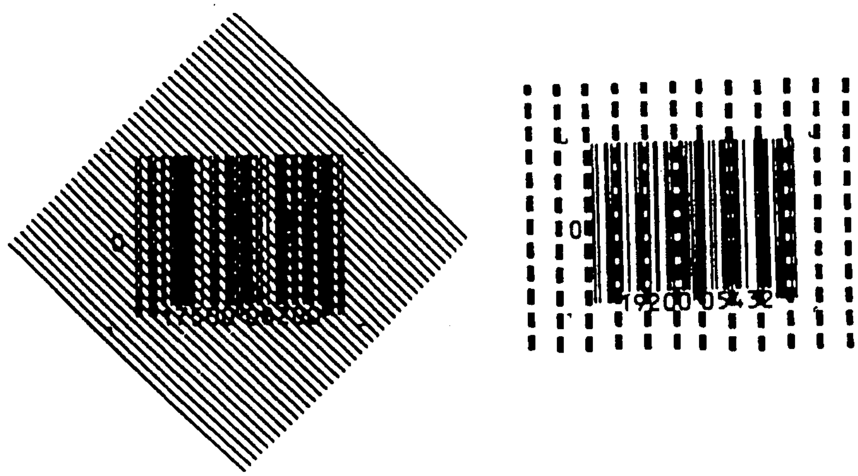


FIGURE 5D — PATTERNS WHICH DO NOT OBSCURE THE SYMBOL



Appendix F
Practical Considerations for Retail Organizations

F.1 Assuring U.P.C. Symbol Quality

The purpose of the U.P.C. quality program is to provide for U.P.C. symbols which can be scanned easily and quickly on the entire range of installed and future equipment. A good symbol should be expected to scan on the first attempt, whereas a bad one may scan only with difficulty, or not at all. A retailer with a single make and model of point of sale (POS) scanner can simply scan a questionable package. If it scans easily and repeatedly, then clearly, for his purposes, it is a good symbol. In this environment, by far the best predictor of scanning, and therefore meaningful symbol quality, is the POS scanner itself.

The following steps are suggested for evaluating the quality of a new U.P.C. symbol in a specific retail organization.

1. Scan the symbol with any available U.P.C. scanner. Assure that the bar coded number is consistent with the human readable U.P.C. number, that the number is on file, and that the on-file product description matches the product.

2. Visually check the symbol magnification, quiet zones, and truncation using a transparent template. Check for reasonable symbol location by answering the question, "Can my scanner easily see the U.P.C.?"

3. Assure that the symbol scans quickly and repeatedly with a scanner that is typical of your installed units. For organizations that employ two or three different models of scanners, determine which of your scanner types is the least aggressive and use one of these for screening new products.

4. Verify only those symbols that have unacceptable scanning performance.

A program to automatically and continually monitor the scanning performance of products at the point of sale is recommended. Software is available to collect data on each U.P.C. number as to how many times it has been scanned and how many times it has been keyed. Products for which the U.P.C. number is keyed more often than some minimal frequency can be listed on a report.

F.2 Verifying Symbols on Packages

Verifiers fall into two principal categories: contact and non-contact. Contact verifiers use hand held optical wands, while the non-contact types use a scanning beam from a laser or other light source. Repeatable results with all types of verifiers are most easily obtained when:

1. The U.P.C. symbol is on flat surface.
2. The background has a matte (not glossy) surface finish.
3. The printed material is opaque.

Boxes of breakfast cereal, paperback books, and garment hang tags meet these criteria. U.P.C. symbols on rigid curved surfaces are somewhat more difficult to verify with confidence because the wand or scanning beam must maintain a specified distance and angle to the bar code in order to measure it accurately.

Flexible packages such as plastic bags require particular skill and patience to verify. The package should be flattened, if possible, in the region of the bar code. Wand verifiers require a light touch and smooth motion, which is often difficult to do with lumpy contents. Several profiles should be taken and judgment used to select which to accept. The grade for each profile on a flexible package reflects both the underlying symbol quality and the operator's technique, particularly when using a wand verifier. If for example, the following profile grades were obtained on a difficult package:

unrecognized (no data)
F (0)
D (1)
unrecognized (no data)
C (2)
F (0)
C (2)

it would be reasonable to interpret this as a C quality bar code, so long as visual inspection shows that the symbol looks reasonably uniform from top to bottom. The operator can inadvertently influence the grade to be lower than it should be, but operator error will seldom result in a score that is too high.

Flexible packages are more easily verified with the contents removed. However, the printed material is often translucent, so that removing the contents alters the optical properties of the symbol. When verifying an empty translucent package, the bar code should be placed over a flat backing material which is visually similar to that of the original contents. Quite different grades may result from using an opaque white backing versus a black backing.